ENGINEERING NEWS

THE Austrian Society of Engineers and Architects has voted in favor of a plan of annual excursions to distant countries. The advantages of annual excursions to visit engineering works are well known to the members of the American Society, although we do not leave our own country. The Austrian engineers expect to start May 16, and visit Bosnia, Herzegovina and Dalmatia, stated to be highly interesting countries for engineers. It is proposed to charter a steamer for part of the trip and to be absent 15 days. The first day will be spent at Fiume, for an examination of the new harbor and works for coal-oil transhipment. The afternoon of the second day is set down for a visit to the "highly interesting" Kerka falls. During the third day, the new railway shops, etc., of the government railway at Kuin, will be inspected and opportunity offered to examine some of the Dalmatian architectural relics, said to be very interesting. At Castelvecchio a steamer will be taken, and a trip made to Trau, thence to Epalato and Salona, the latter being one of the important cities of the old Roman Empire, where at present excavations are being made. Nearly every day some landing is to be made to examine harbors, river improvements, forts, railroads, bridges, etc. On the 11th and 13th days out, coal mines and manganese works are to be visited. The total expense per person, is estimated at about $7 per day. Next year the Society proposes to visit Greece and Constantinople.

THE Royal Technical School at Berlin has at its disposal an annual sum of $500, to be given to the student or post-graduate, who is best able to make an examination and report on certain foreign engineering works. The subject selected for the present year is: "The Railroad Facilities of London." The points which are to be inquired into, and shown by drawings and statistics, are minutely stated and are selected to give new and valuable information, and to be of some permanent use for the profession, instead of being simply for the student's own instruction. It is a very commendable plan certainly, and worthy of imitation.

THE sleeping-car fare from Liverpool to London on the London & Northwestern Railway is only $1.20, the regular fares being first class, $7.00; second class, $5.20; third class, $4.00. First class tickets only are good for sleepers, so that, as compared with second class tickets the extra fare is $3.00. Sleeper fares are lower in England than in America, although on the Continent they are much higher.

FOR the triple-expansion engines with forced draft now being fitted to the vessels of the British Navy, a usual piston speed is from 800 to 900 ft. per minute. In the Medea, with vertical engines, to be tried this year, the designed revolutions are 140, with 3 ft. 3 ins. stroke, or a piston speed of 910 ft. per minute. This speed has not been exceeded in any engines, except in those of the torpedo-boat type, which are invariably vertical.

OPEN cars have recently been built for a tramway in the Argentine Republic having 7 rows of transverse seats on the first floor and a double row of seats back to back on the roof. Stairways go up from the end platforms, and a foot board runs the entire length of the car. The car weighs 5,200 lbs. and has a seating capacity of 35 below and 24 above.

THE Southern Pacific Railway Co. has finally been shamed into replacing its old straight air-brake, which was a constant source of danger and caused many accidents, by the new Westinghouse brake. The cost per car will be about $90.

IT is reported that the Wabash Railway Co. has made some very satisfactory tests of the American Brake Co's. new air-brake, which that company has been engaged in developing since it ceased to push its original buffer-brake. A feature of the brake is that it is released by admitting additional pressure into the pipes.

THE Lake Shore & Michigan Southern Railway Co. is placing only paper wheels under its locomotive tanks and using them in the pony trucks under the front of the engine, making the improvement as fast as the engines come into the shops.

AN association has been formed for promoting the improvement of roads in New York State, and a bill is to be introduced in the legislature for the creation of a road commission, levying a small tax throughout the State, and for the inauguration of some system of making good roads. There is certainly need of such an association, and work for it to do, and we hope it will receive the encouragement from the public which it deserves, and accomplish a great deal of good.

GENERAL MANAGER MELLVILLE C. SMITH, of the New York Arcade Railway Company, is quoted as saying that a contract has been entered into with a syndicate of wealthy American and European capitalists, by which the money for pushing the Arcade scheme will be provided, and that the work has been let to six of the best known firms of contractors in this country who will begin work within 60 days. The $3,000,000 cash and $2,000,000 in securities which are required as a guarantee against injury to property are alleged to be ready and to be placed in the public treasury "in a few days." We have heard such things before.

The names of the capitalists are cautiously withheld; and the full page advertisement in last Sunday's *World*, evidently inserted to create a boom, is an evidence that something is lacking. There are certain legal impediments, also, which must be overcome before any company can begin work on Broadway.

According to Corporation Counsel BEEKMAN no notice has been received from the directors of the Arcade road that they intend to begin work. Before they can do so they must file indemnity bonds and receive permission from the Commissioner of Public Works to begin excavations on the streets. Mr. BEEKMAN says that seven corporations are struggling for the possession of Broadway, for the construction of either underground, surface or elevated railroads.

THE bill to forbid the erection of public buildings in the City Hall Park is now in the Governor's hands. It is greatly to be hoped that he will give it prompt approval and ensure the Park against practical destruction, which will be the inevitable result of putting more buildings on it.

IN a special report made May 3 the Railroad Commissioners of Massachusetts say: "Though the difficulties have not all been surmounted, though there is trouble from the leakage of steam and from the freezing of traps and the imperfect action of reducing valves in the engines, the system of heating by steam from the locomotive is not only practicable and conducive to the comfort and safety of passengers, but it is a desirable measure of economy. It should be adopted as the standard throughout this State, and the use of the separate heaters in or under cars should only be permitted in exceptional cases."

IN a recent decision the patents on vestibule cars claimed by the Pullman Palace Car Company were sustained. The Wagner Palace Car Company, however, claim that the patents cover only non-essentials and that their own cars can easily be altered enough to avoid infringement and still retain the essential features of the vestibule car.

THE first general use of vestibule trains is to be made in the West, and closely follows their trial on the eastern trunk lines. It is reported that no less than eight new vestibule trains will be running between Chicago and western points within a few weeks, and that this luxury will be given to the public without extra charge on the part of the railroads.

The new Chicago, Santa Fé & California and the Chicago, Burlington & Quincy, will soon be running vestibule trains between Chicago and Kansas City. The Chicago, Rock Island & Pacific and the Chicago & Northwestern, will start vestibule trains between Chicago and Omaha and St. Paul. The Wabash will run such a train between Chicago and St. Louis; and possibly a through vestibule train between St. Louis and New York. The Michigan Central and Chicago & Alton are also arranging for vestibule trains.

THE most serious railway accident of the week occurred May 5 and was caused by the breaking in two of a freight train of 75 cars on the Philadelphia & Reading Railroad between Mount Carmel and Locust Gap. The train was running at a rapid rate of speed when the coupling between the third and fourth cars broke; the forward section ran for about half a mile before this was discovered and was then being stopped when the second section ran into it. In the third car was a consignment of Dupont powder, dualin caps, and other explosives, which exploded with disastrous results. Near the track were several houses occupied by miners of the Philadelphia & Reading Coal & Iron Co., one of these was wrecked and then set fire to by an overturned cooking stove, a row of 8 houses was burnt. About a dozen cars were destroyed and much damage done by the explosion and flying fragments. Six or seven persons were burnt to death. This accident would not have occurred had the train been fitted with the Westinghouse freight train brake, as the breaking apart of the cars would have stopped both sections of the train.——On May 7 the cylinder head of a locomotive on the Ninth Ave. elevated road, New York, was blown out, and traffic was delayed for some time.

THE following bridge accidents are reported: On May 6, a bridge over the Michigamme river at Floodwood, Mich., on the Milwaukee & Northern Railroad, gave way under a freight train, having been undermined by the floods. The engine and 8 cars went into the river. Two men were killed.——On May 7 the Erie Railroad bridge at Jamestown, N.Y., was destroyed by fire. Loss about $75,000.——Two railroad bridges in Vermont have been washed away.

THE Mississippi river has overflowed in Minnesota and several railroads have been flooded. Several miles of the Chippewa division of the Chicago, Milwaukee & St. Paul Railway have been submerged. Several towns have also suffered from the high water. —— A landslide occurred May 6 at Mikanna Station, O., on the Cleveland & Pittsburg line. The engine and 5 cars of a circus train were derailed. One man was killed and another seriously injured.——Cyclones occurred May 4, in Arkansas and Illinois.

THE Cumberland Valley Railroad has a special car for furnishing electric light at picnics and camp meetings and for removing wrecks after dark. It is a common box car, strongly built, in which is an 8½ H. P. boiler and engine, which runs a 15 arc lamp dynamo. Each lamp is 2,000 candle power. There is a globe rack, a reel containing 3 miles of insulated wire, and all the appliances necessary, including a coal box of 3 tons capacity and water tank of 1,000 galls. capacity. The car has air braking apparatus, and has been very useful. In one year it paid for itself in the increased sale of tickets to picnics and camp-meetings. The Pennsylvania Railroad also hired it to light up the removal of a bad wreck at Duncannon. Such a car would be useful on almost any railway.

THE Woodward Electrical Company have prepared an exhibition plant in Detroit to show the practical working of their storage system. The Main system, controlled by the River & Rail Electric Co. of this city is approaching practical test and is said to be of the highest promise.

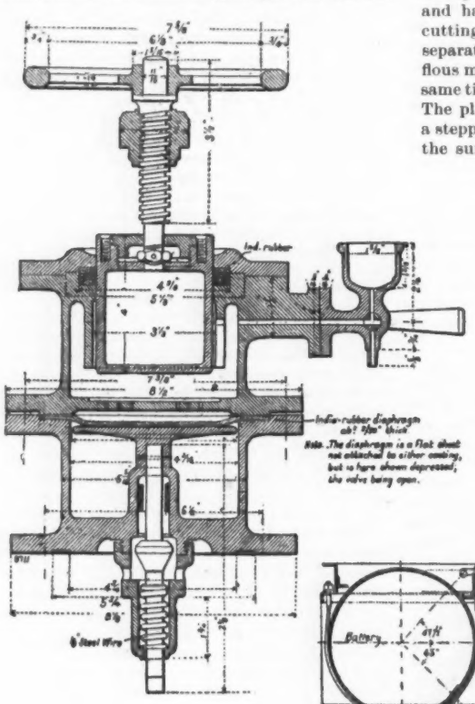
A SLIGHT accident occurred May 1 in the La Salle St. Tunnel, Chicago, in which a wagon was caught between two grip cars. The wagon was closely following a grip car and was itself closely followed by another car which, on the down grade, began crowding the wagon. The driver of the rear car seeing the danger released the cable and applied the brakes, which failed to act quickly enough to avoid crushing the wagon and injuring the horses.

The Mekarski Compressed Air Tram-Car.

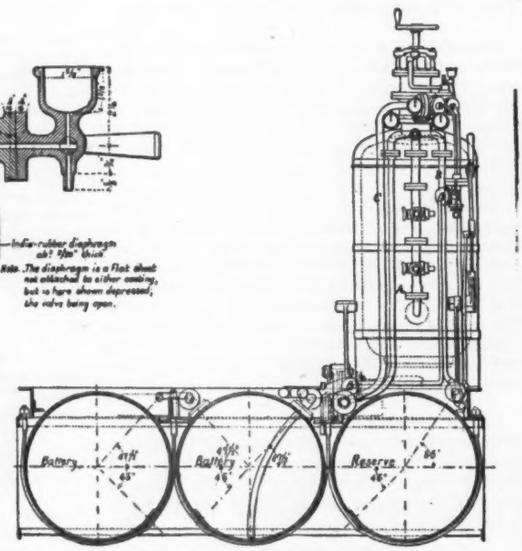
We abstract from *Engineering* a description of this new compressed air car, as now in use on one of the London Street Tramways Company's lines, with illustrations of the more interesting features, especially the reducing or regulating valve, which will be seen to have some features of novelty.

The car travels about 2 miles over a rising and falling line, which has for a length of 100 yds. a gradient of .037 with a curve of 50 ft. radius on the summit, while for three-fourths of a mile the gradient varies from .0166 to .025.

The rails, which are shallow and supported on wooden longitudinal sleepers, were laid a long time ago, and add to the difficulties attending the use of heavy cars on this line. The cars, as modified to suit the requirements of the line, are of 4 ft. 8½ ins. gauge, with a carrying capacity of 38 passengers, a conductor and a driver. They look like horse cars, but have the floors raised to give space for the machinery. Three horizontal cylinders at each end of the car beneath the floor carry the air at a pressure of 450 lbs. per sq. in., 5 of these 6 reservoirs are connected by pipes, forming the "battery," the sixth, called the "reserve," being independent. A "hot-pot" at each end of the car contains hot water taken from a steam boiler under 80 lbs. per sq. in. pressure. The air is made to bubble up through this hot water before entering the high pressure cylinder, and after the first expansion it passes through a heater immersed in this water to the low pressure cylinder. Heating the air prevents ice forming in the cylinders and slightly increases its volume, while the air passing through the "hot-pot" picks up sufficient moisture for the lubrication of valves and cylinder. The reserve is only called upon in case of emergency, as when a steep rise is encountered near the end of a long run when the air pressure has fallen, or when a stop is made half way up a hill. In such cases the air from the reserve at the full pressure of 450 lbs. per sq. in. can be relied upon to help the car over the difficulty.



Regulating Valve.



Section of Batteries, Showing Engine.

THE MEKARSKI COMPRESSED AIR TRAM-CAR

A regulating valve is fixed at the top of each hot pot, a single hand-wheel being provided for both, to prevent anyone tampering with the one not in use. We show a section of this valve, which is a special feature of the car. There is no rigid connection between the valve at the bottom of the casing and the hand-wheel above. The rotation of the hand-wheel forces a plunger into a closed vessel filled with liquid and opens the valve. The bottom of this vessel is a brass-faced rubber diaphragm to which is attached a spindle with its lower end in contact with the valve, which is held up by a spring. By this means the driver controls the pressure of the air admitted to the engine according to the requirements of the line.

The battery and reserve are connected with the hot-pots by ¾-in. pipes provided with cocks for controlling the supply. The air passes to the high-pressure cylinder through 1-in. pipes and the exhaust goes back to the hot-pots through 1½-in. pipes.

The high-pressure cylinder is 5¼ ins. in diameter, and the low-pressure cylinder 8 ins. in diameter, the stroke of both being 8 ins. They drive a crank-shaft, geared to the driving axle by compound spur-wheels of special construction. These wheels have been designed to run without noise and vibration, and they fulfill their object very completely, since it is impossible to hear them even when sitting immediately over them. Each wheel is formed of four steel plates which were originally clamped together, and had the teeth formed on them in a wheel-cutting machine. The plates were then placed separately in a lathe, and a good deal of the superfluous metal was removed to lighten them, and at the same time the teeth were slightly reduced in width. The plates were then bolted together so as to make a stepped wheel, brown paper being inserted between the surfaces in contact, and the hollow spaces between the plates being filled with hard wood to deaden the sound. To keep the wheel always accurately in pitch in spite of the play of the springs of the car, a novel arrangement of axle-box has been introduced. The box is curved and plays in guides curved to a radius struck from the center of the crankshaft. Thus, however much the car body may rise or fall, the pitch circles of the two wheels always remain in contact.

In addition to the regulator and the reversing lever there is a foot brake and an air brake, which can be applied either by hand or by the automatic action of a centrifugal governor. This governor is driven by a band from the axle, and operates a valve by which air is admitted from the reserve to the brake cylinder. Putting on the air brake automatically cuts off the supply of motive fluid to the engine by admitting the pressure to act upon a piston which operates a valve in the main air pipe. The governor does not open its valve until the speed of the car exceeds 10 miles an hour, when it immediately puts on the brake and shuts off the air. As soon as the speed falls the brake comes off, and the engine starts again without attention on the part of the driver. There is also a speed indicator driven by a band. The frame of the car is strengthed by a truss which rises to the level of the underside of the seat. For moving it in the shed there is provided a hand turning gear, consisting of teeth cast on the inside of one of the driving wheels, and engaging with a three-toothed pinion turned by a handle.

It is to be regretted that no figures concerning the cost of running this car were given. It is one of the most novel and interesting of the many attempts that have been made to do away with horses as a means of moving cars. The Mekarski system has been in use in London for some years.

Drainage Tables.*

BY GEORGE H. JOHNSON, C. E., S. B., Lincoln, Neb.
B. & M. R. R. R.

(*Conduded from page 357.*)

Head	Q = 2269	2521	3025	3529	4033	4537	5042	5546	6050	6555
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
8	12·6	13·3								
10	12·0	12·6								
12	11·5	12·1	13·1	14·2	15·2	16·2	17·0	17·9	18·7	19·5
14	11·1	11·7	12·7	13·7	14·7	15·6	16·4	17·3	18·0	18·8
16	10·7	11·3	12·3	13·3	14·3	15·1	15·9	16·7	17·4	18·2
18	10·4	11·0	12·0	12·9	13·8	14·7	15·5	16·2	16·9	17·7
20	10·2	10·7	11·7	12·6	13·5	14·3	15·1	15·8	16·5	17·2
22	10·0	10·5	11·4	12·4	13·2	14·0	14·7	15·4	16·1	16·8
24	9·8	10·3	11·2	12·1	12·9	13·7	14·4	15·1	15·8	16·5
26	9·6	10·1	11·0	11·9	12·7	13·5	14·2	14·9	15·5	16·2
28	9·5	10·0	10·8	11·7	12·5	13·3	14·0	14·6	15·3	15·9
30	9·3	9·8	10·7	11·5	12·3	13·1	13·8	14·4	15·0	15·6
32	9·2	9·7	10·5	11·4	12·1	12·9	13·6	14·2	14·8	15·4
34	9·1	9·5	10·4	11·2	12·0	12·7	13·4	14·0	14·6	15·2
36	9·0	9·4	10·3	11·1	11·8	12·5	13·2	13·8	14·4	15·0
38	8·9	9·3	10·1	11·0	11·7	12·4	13·1	13·7	14·3	14·8
40	8·8	9·2	10·0	10·9	11·6	12·3	12·9	13·5	14·1	14·7
42	8·7	9·1	9·9	10·7	11·5	12·1	12·8	13·4	14·0	14·5
44	8·6	9·0	9·8	10·6	11·4	12·0	12·7	13·3	13·8	14·4
46	8·5	8·9	9·7	10·5	11·3	11·9	12·5	13·1	13·7	14·2
48	8·4	8·8	9·7	10·4	11·2	11·8	12·4	13·0	13·6	14·1
50	8·4	8·7	9·6	10·3	11·1	11·7	12·3	12·9	13·5	14·0

Head	Q = 7058	7562	8066	8570	9074	9578	10083	11343	12604
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
12	20·3	21·0	21·7	22·4	23·1	23·8			
14	19·5	20·2	20·9	21·5	22·2	22·8	23·4	24·8	26·4
16	18·9	19·5	20·2	20·8	21·4	22·0	22·5	23·9	25·2
18	18·3	19·0	19·6	20·1	20·7	21·3	21·9	23·2	24·3
20	17·8	18·5	19·1	19·6	20·2	20·7	21·3	22·5	23·7
22	17·4	18·0	18·6	19·2	19·7	20·2	20·8	22·0	23·1
24	17·0	17·6	18·2	18·8	19·3	19·8	20·3	21·5	22·7
26	16·7	17·3	17·9	18·4	18·9	19·5	20·0	21·1	22·3
28	16·5	17·0	17·6	18·1	18·6	19·1	19·6	20·8	21·9
30	16·2	16·8	17·3	17·8	18·3	18·8	19·3	20·4	21·5
32	16·0	16·5	17·0	17·5	18·0	18·5	19·0	20·1	21·2
34	15·8	16·3	16·8	17·3	17·8	18·3	18·7	19·8	20·9
36	15·6	16·0	16·6	17·1	17·6	18·0	18·5	19·6	20·6
38	15·4	15·9	16·4	16·9	17·4	17·8	18·3	19·3	20·4
40	15·2	15·7	16·2	16·7	17·2	17·6	18·1	19·1	20·1
42	15·0	15·6	16·1	16·5	17·0	17·4	17·9	18·9	19·9
44	14·9	15·4	15·9	16·4	16·8	17·3	17·7	18·7	19·7
46	14·8	15·3	15·7	16·2	16·6	17·1	17·5	18·5	19·5
48	14·6	15·1	15·6	16·0	16·5	16·9	17·3	18·3	19·3
50	14·5	15·0	15·5	15·9	16·3	16·8	17·2	18·2	19·1

Head.	Q = 13864	15125	17646	20167	22687	25208
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
14	27·6					
16	26·4	27·7	29·9	32·0		
18	25·5	26·7	28·9	30·9	32·8	
20	24·9	26·0	28·1	30·0	31·9	33·4
22	24·3	25·4	27·4	29·2	31·1	32·5
24	23·8	24·9	26·7	28·5	30·4	31·8
26	23·3	24·4	26·2	28·1	29·8	31·2
28	22·9	23·9	25·8	27·6	29·3	30·7
30	22·6	23·5	25·4	27·2	28·8	30·2
32	22·2	23·2	25·0	26·8	28·4	29·8
34	21·9	22·8	24·6	26·4	28·0	29·4
36	21·6	22·5	24·3	26·0	27·6	29·0
38	21·3	22·3	24·0	25·7	27·2	28·6
40	21·1	22·0	23·7	25·3	26·9	28·2
42	20·9	21·8	23·5	25·1	26·6	27·8
44	20·6	21·5	23·2	24·8	26·3	27·5
46	20·4	21·3	22·9	24·6	26·0	27·3
48	20·2	21·1	22·6	24·3	25·7	27·0
50	20·0	20·9	22·5	24·1	25·5	26·8

REMARK 1. We have assumed that the head of water is measured in still water; *i.e.*, that the reservoir is so large that the velocity of approach to the orifice may be neglected in comparison with the velocity of flow in the pipe. If this assumption is not sufficiently accurate, we can substitute for the measured head the effective head given by the formula $h' = h + \frac{V^2}{2g}$ where h denotes the measured head and V the velocity of approach to the pipe.

REMARK 2. The Table gives the diameters of *circular* pipes of given length which will discharge given volumes of water per second under a given head. When culverts of rectangular cross-section are used equations (2, *a*) and (3, *a*) should replace (2) and (3). But for such short pipes as we consider the sectional areas will be nearly equal, whichever form of cross-section is adopted.

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REMARK 3. The coefficient of resistance at the orifice of a pipe whose thickness is less than ½ its diameter is a function of the angle between the axis of the pipe and the face of the wall or the side of the embankment in which it is inserted.

For example, a culvert having a horizontal axis and ends complanar with the sides of an embankment sloping 1½ to 1 will have for the coefficient of resistance at the orifice .743 instead of .505, and the coefficient of influx and the velocity of the water in the culvert would be considerably decreased.

REMARK 4. It should be noticed that usage is not uniform in regard to the notation for the coefficient of friction. The factor which DARCY, FANNING and some other writers denote by m and call the coefficient of friction is $\frac{z}{4}$, and hence in using the empirical tables of the coefficient of friction which have been published by these writers, we must always take $z = 4\,m$. We have adopted WEISBACH'S notation which is generally the simplest.

REMARK 5. The coefficient of friction is of course dependent on the material of the pipe and the condition of the interior surface. Masonry lined with cement has nearly the same coefficient as cast-iron. Experiments made by WEISBACH show that the coefficient for wood is 75 per cent. greater than for iron. When the pipe is laid in sections the coefficient will generally be increased by resistance at the joints.

REMARK 6. In computing Table IV we assumed $l = 15 + 3\,h$; if, however, the top of the embankment is more than 15 ft. wide, or if the slopes are less than 1½ to 1, the ratio l will be increased, and consequently by equation (3) v will be decreased and d must be increased. In railroad practice this correction, as well as those mentioned above, will always be small and may often be neglected.

EXAMPLE. Given $Q = 504$; $h = 22$; $l = 18 + 4\,h = 18 + 4 \times 22 = 106$. Required to find d.

From Table IV under $Q = 504$ and opposite $h = 22$ we find $d = 4.8$. But this diameter was computed on the assumption $l = 15 + 3\,h = 15 + 3 \times 22 = 81$, which gives us $\frac{l}{d} = \frac{81}{4.8} = 17$ whereas in this example we have approximately $\frac{l}{d} = \frac{106}{4.8} = 22$. Referring now to Table III. we find the corresponding coefficients of discharge to be .735 and .715; hence we have the proportion: Required diameter : 4.8 : : $\sqrt{.735}$: $\sqrt{.715}$; *i. e.* the computed diameter must be increased 1½ per cent. approximately.

So far we have assumed that the reservoir is full when the rain begins, and that the water immediately flows off under the maximum head. This assumption of course is always safe, and it is also necessary for a rainfall of indefinite duration.

The theoretical velocity varies as the square root of the head; and hence if we suppose the available rainfall to exceed the discharge in such a proportion that the head of water in the reservoir increases uniformly from 0 to the maximum during the period of fall into the reservoir, then it is evident from a table of squares that the mean velocity of discharge will be about two-thirds of the velocity under maximum head.

Therefore we proceed as follows: We assume that while the reservoir is filling, the ratio of the total quantity of water discharged to the quantity which the pipe might have discharged under the maximum head is as 2 to 3. When the ground is frozen it is possible that an inch or more of water for the whole area drained should come to the pipe or culvert every hour for several hours in succession.

If we assume 1 in. per hour for 3 hours as the maximum available rainfall or flow into the reservoir, the discharging capacity of the pipe being only ¼ in. per hour under the maximum head, then the reservoirs should be large enough to contain $3 - \frac{3}{6} =$ 2½ ins. of water for the whole area. Supposing that this condition is satisfied there would be no overflow even though the 3 hours of heavy rain should be succeeded by an indefinite period during which the available fall might be ¼ in. per hour.

The following problem may now be discussed as a generalized form of our original problem:

Having given the drainage area = A acres; the capacity of the reservoir expressed in inches of available rainfall for the whole area = c; the maximum available rainfall for the whole area in b hours = a; the head of water measured from the axis of the pipe to the level of still water = h; and the length of the pipe = $l = 15 + 3\,h$; it is required to find the diameter of the smallest pipe that will drain the reservoir without any overflow of the embankment.

It will be found convenient to write the notes on drainage areas on blanks having 12 or 14 columns, thus:

1. Corporate name of the road.
2. Number of the pipe or culvert.
3. Station, or location of the pipe.
4. Maximum safe head (= h) at center of pipe.
5. Length of the pipe = l.
6. Drainage area in acres = A.
7. Reservoir in acres = A^1.
8. Average depth of the reservoir in inches = k.
9. Capacity of the reservoir in inches of water over the whole water-shed = c.
10. Slope of the water-shed, and character of the soil and vegetation.
11. Greatest volume of water that can reach the pipe expressed in cubic feet per second = Q.
12. Theoretical diameter necessary for the pipe under the specified conditions = d.
13. Pipe or other structures decided on.
14. Remarks.

The maximum safe head should generally be taken several feet less than the height of the embankment. The 9th column may be deduced from the 3 preceding columns by using the equation

$$c = \frac{A^1}{A}\,k \qquad (7)$$

Example. Given $A = 2{,}000$, $c = 2$, $h = 30$, $l = 105$. It is required to find the diameter, d, assuming the greatest available rainfall to be 5 ins. in 3 hours.

Solution. We have $a = 5$, $b = 3$. The quantity to be discharged in 3 hours is $a - c = 5 - 2 = 3$ ins., or 1 in. per hour over 2,000 acres. This will require as large a pipe as would be necessary to discharge, under the maximum head, 1½ ins. over 2,000 acres = 3,025 cu. ft. per second. Now from Table IV under $Q = 3{,}025$ and opposite $h = 30$ we find immediately $d = 10.7$.

In every case where the reservoir is to be considered we find Q from the equation

$$Q = \frac{3}{2}\cdot\frac{a-c}{b}\cdot\frac{3630}{60 \times 60}\,A \qquad (8)$$

The first factor of the second member is only approximate, and hence the third also may be taken approximately; thus we have

$$Q = \frac{3}{2}\cdot\frac{a-c}{b}\,A \qquad (8\,a)$$

But if the capacity of the reservoir does not exceed one-third of the total available rainfall in any one period, *i. e.* if $3\,c \leq a$, we have no need to consider the reservoir at all, since in this case it will just hold enough water to compensate for the difference between the actual discharge from the pipe, and the possible discharge under the maximum head in the given period of b hours.

In other words, if the reservoir is filled before the maximum flow of water into it ceases, the pipe must then be as large to prevent overflow as if the reservoir had been full at the beginning.

In filling the 11th column with the maximum available rainfall at the orifice of the pipe, it is necessary to consider not only the actual maximum rainfall on the whole drainage area, but also the form and extent of the area, the slope of the surface, and the character of the soil and vegetation. Several formulas have been proposed for finding the available rainfall when these circumstances are known. But as the different formulas give results which are very discordant, it is evident that they are not to be relied on.

The safest method is to make several independent reasonable hypotheses in regard to the available rainfall, and then adopt the greatest resulting diameter. Sometimes a long-continued moderate rain will require a larger discharge pipe than a very heavy short rain; this depends on the capacity of the reservoir. Both assumptions should always be made.

To facilitate this work, Tables V and VI have been prepared which enable us to take account of the reservoir without using equation (6). They are adapted especially for use in the field, since they require no reference to the preceding formulas and tables.

TABLE V.

(*A.*) For an available rain-fall of ½ in. per hour for 12 hours on a drainage area of 100 acres. Value of d in feet.

Head in ft.	Capacity of the reservoir = c.								
	2 ins. or less	2½ in.	3 in.	3½ in.	4 in.	4½ in.	5 in.	5½ in.	6 in.
	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.	ft.
8	1.97	1.87	1.74	1.59	1.44	1.24	1.06	.82	0
10	1.88	1.78	1.66	1.51	1.39	1.19	1.02	.78	0
12	1.82	1.73	1.61	1.45	1.35	1.15	.99	.76	0
14	1.77	1.68	1.57	1.41	1.31	1.12	.96	.74	0
16	1.73	1.64	1.54	1.38	1.28	1.10	.94	.72	0
18	1.69	1.60	1.51	1.35	1.26	1.09	.93	.70	0
20	1.66	1.57	1.48	1.33	1.24	1.07	.92	.69	0
22	1.64	1.55	1.45	1.31	1.22	1.06	.91	.68	0
24	1.63	1.53	1.43	1.30	1.21	1.05	.90	.67	0
26	1.62	1.52	1.41	1.29	1.20	1.04	.89	.66	0
28	1.60	1.51	1.39	1.28	1.19	1.03	.89	.66	0
30	1.59	1.50	1.38	1.27	1.18	1.02	.88	.65	0
34	1.56	1.47	1.36	1.25	1.16	1.01	.87	.64	0
38	1.54	1.45	1.34	1.23	1.14	1.00	.86	.63	0
42	1.52	1.43	1.33	1.22	1.13	.99	.85	.63	0
46	1.50	1.41	1.31	1.21	1.12	.98	.84	.62	0
50	1.48	1.40	1.30	1.20	1.11	.97	.83	.61	0

(*B.*) For an available rainfall of 3 ins. in 5 hours on a drainage area of 100 acres. Value of d in feet.

Head in ft.	Capacity of the reservoir = c.				
	1 in. or less	1½ in.	2 in.	2½ in.	3 in.
	ft.	ft.	ft.	ft.	ft.
8	2.15	1.89	1.55	1.13	0
10	2.04	1.80	1.48	1.08	0
12	1.98	1.74	1.43	1.04	0
14	1.94	1.69	1.40	1.02	0
16	1.90	1.64	1.37	1.00	0
18	1.86	1.61	1.34	.98	0
20	1.83	1.58	1.32	.96	0
22	1.81	1.56	1.30	.95	0
24	1.79	1.54	1.29	.94	0
26	1.77	1.53	1.28	.93	0
28	1.75	1.52	1.27	.92	0
30	1.74	1.51	1.26	.91	0
34	1.72	1.48	1.24	.90	0
38	1.70	1.46	1.22	.89	0
42	1.68	1.44	1.21	.88	0
46	1.67	1.42	1.20	.87	0
50	1.66	1.41	1.19	.86	0

(*C.*) For an available rainfall of 5 ins. in 3 hours on a drainage area of 100 acres. Value of d in feet.

Head in ft.	Capacity of the reservoir = c.						
	½ in. or less.	2½ in.	3 in.	3½ in.	4 in.	4½ in.	5 in
Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
8	3.51	3.05	2.77	2.41	1.97	1.43	0
10	3.35	2.91	2.64	2.31	1.88	1.37	0
12	3.22	2.80	2.54	2.21	1.82	1.33	0
14	3.12	2.71	2.46	2.14	1.77	1.29	0
16	3.04	2.64	2.38	2.09	1.73	1.26	0
18	2.97	2.58	2.31	2.04	1.69	1.24	0
20	2.91	2.54	2.27	2.00	1.67	1.22	0
22	2.86	2.50	2.25	1.96	1.65	1.20	0
24	2.81	2.46	2.23	1.93	1.63	1.19	0
26	2.77	2.42	2.21	1.91	1.62	1.18	0
28	2.74	2.39	2.19	1.89	1.61	1.17	0
30	2.71	2.37	2.17	1.87	1.59	1.16	0
34	2.65	2.33	2.13	1.83	1.56	1.14	0
38	2.61	2.29	2.10	1.80	1.54	1.12	0
42	2.58	2.26	2.07	1.78	1.52	1.11	0
46	2.55	2.23	2.05	1.76	1.50	1.10	0
50	2.52	2.21	2.03	1.74	1.48	1.09	0

TABLE VI.

Approximate Multipliers for the Diameters in Table V.

Area.	Mult.	Area.	Mult.	Area.	Mult.
50	.71	900	2.72	3600	5.3
100	1.00	1000	2.86	4000	5.5
200	1.37	1200	3.2	5000	6.1
300	1.64	1600	3.7	6000	6.7
400	1.87	2000	4.1	7000	7.2
500	2.07	2400	4.4	8000	7.7
600	2.25	2800	4.7	9000	8.2
700	2.41	3200	5.0	10000	8.6
800	2.57				

These multipliers will be too small for small heads and small reservoirs; and too large for large heads and large reservoirs. In most cases, however, they will be correct within 2 per cent., but in extreme cases they may be too large or too small by 8 or 9 per cent.

Example. Given:—An available rainfall of 3 ins. in 5 hours on 1,600 acres, which flows into a reservoir of 2 ins. and is to be discharged from thence under a maximum head of 18 ft. Find the diameter of the smallest pipe that will satisfy the conditions.

In Table V. (*B*) opposite $h = 18$, and under reservoir = 2, we find $d = 1.34$; and by Table VI. the

required diameter = $1.34 \times 3.7 = 4.96$ approximately.

Using the more exact Table IV. and equation (6) we get $d = 4.89$.

The zeros in the last column of Table V. show simply that when the capacity of the reservoir equals or exceeds the total rainfall no pipe is required to prevent overflow.

Racine Water-Works*

Racine, Wis., is situated on the west shore of Lake Michigan, 62 miles north of Chicago, and is reached by either the Chicago & Northwestern, or the Chicago, Milwaukee & St. Paul. It has a population of 20,000.

Up to 1886, dug and artesian wells and cisterns supplied all water used for domestic purposes, and nearly all required for fire protection. In the spring of that year a contract was made with the Racine Water Company to furnish Lake Michigan water for these purposes, the intake to be located a mile and a quarter from shore, in 40 ft. of water. The works as completed consist of about 1¼ miles 24-in. suction main, 31½ miles of force and distribution pipe, besides hydrant connections and blow offs, making about 34 miles in the system, with which are connected 310 fire hydrants and 335 gates. The smallest distribution pipe is 6 ins. in diameter. There are 3 river crossings of 24-in., 20-in., and 8-in. cast-iron pipe, of which the first two are laid in a trench 22 ft. and the last 18 ft. below the surface of the river. There is a stand-pipe 25 × 90 ft., rising 200 ft. above the lake, while water is raised by 2 Blake duplex pumping engines of an easy aggregate capacity of 4,500,000 galls. per 24 hours. One of these engines is compound and one high pressure, and both are connected with independent condensers, air pumps and heater, so arranged as to exhaust to either the condenser or atmosphere through the heater, or to the atmosphere direct. Power is supplied by a battery of 4 boilers, each 16 ft. long, 72-ins. in diameter, with 92 3½ in. tubes. The chimney is 100 ft. high with flue 5 ft. square. The boilers are fed by 2 No. 4 Blake boiler feed pumps, drawing their water from either the hot or supply well, while connection is also made with the force main, and each boiler is fitted with a Hancock inspirator connected with supply well. Having thus briefly described the works as a whole, a more minute description of a few details of construction may be of interest.

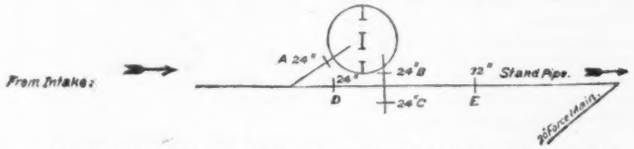


Fig. 1.—Racine Water-Works. Arrangement of Gates at Pump Well.

FOUNDATION AND PEDESTAL FOR STAND-PIPE.

The highest elevation within city limits is 55 ft. above the lake. An elevation of 200 ft. was desired for top of tank, and as all water contained below tops of the highest buildings is of very little practical value in a city where street pressure is depended upon to do all the work, the tank was set 55 ft. above the original surface of the ground or 110 ft. above lake datum, upon a foundation and pedestal of beton carried to this height.

Of this structure the following are the principal dimensions: Depth of foundation below original surface, 7 ft.; diameter at base, 37 ft.; of shaft or pedestal, 26½ ft.; height of same, 55 ft.; in plan 10½ ft.; of core, hollow angular ring 4 ft., solid outside ring 4 ft.; total, 26½ ft.; height of beton above base 62 ft. Allowing 130 lbs., to the cu. ft., the weight of concrete is 4,212,000 lbs., of the tank and water 2,874,000 lbs., a total of 7,086,000 lbs. giving a pressure of 3.3 tons per sq. ft. of underlying earth. This earth is a very tenacious clayey hardpan, fairly dry and well drained by its natural position, though no pains was taken to lead ground water away from the base. The first 5 courses were each 18 ins. in height and stepped back 1 ft. each to the last or fifth, on which started the pedestal proper; below this point and for 18 ins. above, the entire base was solid; the core then retreated by steps of 1 ft. rise and tread to the size designated, thus distributing the load pretty uniformly over the entire base. At 19, 37 and 55 ft. above the ground the core and external ring were joined and bonded together by semi-circular arches and floors, the latter 2 ft. thick at crown of arch, except the upper floor, which was 4 ft. at same point. Sixteen 1-in. round iron clamps were imbedded in each floor from near external surface to within about a foot of center of core, to increase the tensile strength bonding of the floors, in case of any settlement.

The material used in construction was Saylor's American Portland cement and lake beach sand and gravel properly screened, mixed dry, in proportion of 1 of cement to 9 of sand and gravel; the latter graded on the beach by a cheap rotary screen of wire cloth, of 3 different meshes, supported on a light frame-work of iron and run by a small portable steam engine. The sand and gravel were mixed in those proportions which gave the least volume of voids, though the proportions of different grades of gravel were varied slightly from time to time to best utilize the product of the screen. The sand and gravel were hauled about 1½ miles to site of stand-pipe, where they were stored in bins beside the mixing platform. This platform was about 16 ft. square and of the right height to feed into power mixer. This mixer consisted of an iron shaft about 4 ins. in diameter, with steel paddles about 2¼ × 3½ ins. arranged spirally around it, their faces set at such an angle as to push the material toward the elevator end of shaft. The shaft and paddles were enclosed in a boiler plate cylinder about 8 ft. long and of slightly greater diameter than the outside of paddles, flanged on each side for convenience in opening, and mounted in a heavy oak frame. On one end of shaft was a large gear, connected with a smaller one on counter shaft and pulley, with belt to an 8 H. P. portable steam engine. At the other end of shaft, which was extended some distance beyond cylinder, for purposes of clearance, was attached a small gear wheel, connecting with elevator, running in cast-iron boot below and at end of cylinder.

The elevator was composed of a chain of malleable iron links, with cast-iron buckets, running on sprocket wheels above and below. The buckets were at first set every third link, or a little more than a foot apart, but as these interfered with each other in discharging over the upper wheel, and as the rate of motion to discharge of mixer was ample, every other bucket was removed. With the progress of the work the framework and upper wheel were raised and the chain lengthened as required. The mortar thus raised and discharged like grain, a further idea similarly suggested itself of carrying the frame and upper wheel sufficiently high to discharge through swinging spouts upon that portion of the work desired. It was found, however, that the finer material would lodge and stick without provocation, choking the spout, while the larger material, pebbles and stone, would run away from the finer, and no matter how thoroughly mixed it left the mixer, it reached the work as if it had again passed through the screens. After trying various sizes of spouts at different angles of elevation, and with the mortar at different degrees of moisture, the spout was abandoned and a platform built at such height below the upper sprocket wheel that the buckets discharged directly into wheelbarrows, in which the material was wheeled from the platform on runs and dumped where wanted. There were two beds upon the mixing platform, each holding "one batch" or 10 barrels of dry material. After delivery into beds, which was done in layers, it was twice turned over dry, then wet according to condition of material and temperature of atmosphere, the standard being "all the water possible without the concrete becoming shaky under thorough tamping." This usually leaves the mixture so dry that one unaccustomed would be afraid to use it, but really of the degree of moisture susceptible of the most complete tamping. After wetting the material was again turned and then delivered into the mixer, from which it issued with the cement, sand and gravel thoroughly incorporated in one mass.

The outside of pedestal was composed of 2 parts sand and 1 part cement, mixed by hand to the same degree of moisture as the interior, and filled in against the mould and submitted to a separate and combined tamping, so that it formed a part of the entire mass and in no sense an outside skin that might peel off. The material was deposited in layers about 6 ins. thick and tamped as fast as delivered, with cast-iron rammers 5 ins. square, weighing about 10 lbs. each. The molds for the different surfaces were constructed of narrow sheathing, 2 ft. 6 ins. long, nailed vertically to ribs cut to the proper circle; the outer molds being held in place between 8 uprights, 6 × 8 ins. each, of 2-in. plank, 8 ins. wide, with broken joints, for convenience of extension. These uprights were held in place by ¾ in. rods, with thread-washer and nut on each end, so as to preserve the correct form, size and vertical line. The rods were threaded through short pieces of wrought-iron pipe of the same length as the thicknesses of concrete, so that they could be easily removed upon completion of the work. The molds were secured or slacked by use of wedges. At their top (on the outside,) and 2 ft. below, were fastened triangular strips (⅛ × ¾ in.) which gave the exterior the appearance of being laid in blocks.

Nearly three months elapsed from commencement of foundation to completion of pedestal, 1,610 barrels of cement were used, and the concrete measured 1,206 cu. yds. in place; the entire cost, including screening, hauling, machinery, tools, stagings, carpenter work, and all expenses was not far from $10 per cu. yd. The only criticism upon machinery is that working material so dry it set and adhered to shaft, cylinder and buckets, so as to require cleaning nearly daily, with a continual charge for renewal of paddles.

Two questions will naturally arise with engineers regarding the work, viz., expediency and durability. The first, each man will have to decide for himself; circumstances might make the cost of such a structure more or less than in this instance, where the cost of cement delivered on the ground was about 36 per cent. of the gross cost. As to durability, the last concrete was put in place late in September; from then till the completion of tank, about the middle of January, the interior was open and equally, with outside, exposed to the air, the temperature falling to 22° below zero, thus insuring the penetration of frost entirely through the structure.

When the tank was first filled one or two overflows (before the exact relation of the particular gauge used to the top of the tank had been determined) nearly covered the exterior with a sheet of ice. Yet notwithstanding the comparative greenness of the mortar, the admission of such intense cold to the interior, and the severe experience of the outside, which certainly is not likely to be exceeded, there has been this summer no perceptible flaking and every grain of sand on both the outer and inner surfaces stands out as sharply and resists removal more strongly than on the day the molds were first removed. With this experience, even though the time elapsed has been so short, the structure seems likely to be as durable as if built in any other form of masonry.

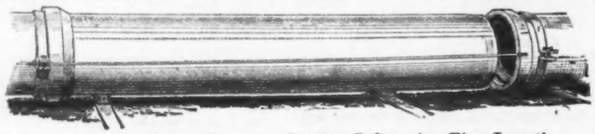


Fig. 2.—Racine Water-Works. Joining Submarine Pipe Lengths.

ELECTRIC VALVE.

There are 2 pipes leading to stand-pipe through hollow annular ring of pedestal, one of 10-in. diameter for purposes of supply, and a 16-in., with check valve, for return flow. In several instances 1 pipe only has been used for both inflow and outflow, with a balanced check-valve, closed by a certain velocity of the inflow. This form, though undoubtedly the more convenient, is open to the objection that the full speed of the pumps cannot be utilized in filling the tank. An ordinary valve was, therefore, inserted in the 10-in. supply pipe, and connected with pulleys and weights, very much after the manner of a fire-alarm striking apparatus. By throwing an electric switch at the pumping station a magnet releases a pawl holding the weights and allows them to fall, closing the gate in about 1¼ minutes, though this speed can be varied if thought desirable. If the pumping ceases, the check valve opens and gives stand-pipe pressure, but no water can be forced into the tank till the 10-in. valve has been opened by rewinding the weights. This delay may sometimes be awkward, but the action is positive, and will not interfere with any action of the pumps unless desired.

PUMP WELLS AND CONNECTION WITH LAKE PIPE.

By the terms of the contract with the city, the intake was to be laid in a trench 10 ft. below the bed of the lake. This required the shore pipe to be laid equally deep at the water line, while as the lake fluctuation between high and low water is about 2 ft., in order to insure the suction pipes being always submerged, the trench at the pump well was excavated 4 ft. below ordinary lake level. The material for this distance, about 400 ft., is firm beach and some pebbles, in which the water stands at same height as lake. As the lake trench had to be made by dredging, exposed to the storm and so requiring a broad surface excavation, the coffer dam for the shore pipe was carried out into 2½ ft. of water, or the necessary depth below water line at that point was 12½ ft. For the first 50 ft., the sheeting used was 6 × 10 ins., 16 ft. long; then 150 ft. of 4 × 10 ins., and the balance 3 × 10 ins., all grooved and splined in proportion to thickness, and driven to the underlying clay, from 14 to 11 ft. below water line, except the upper end of trench, where a shorter plank was used. The sand was so fine it was impossible to drive the sheeting by a hammer, use was, therefore, made of 2 jets of water from a steam pump on pile driver. The water

*A paper by GEORGE A. ELLIS, read before the Boston Society of Civil Engineers, Dec. 21, 1887.

pressure usually carried was about 50 lbs.; size of jets ¾ in. These were attached to poles and pushed down beside of and with the sheeting, much care being required to carry the jets equally on each side; as, if one side was washed clear faster than the other, a crowding followed, which would sometimes split the splines. Each piece was held in place in guides quite tightly, so that often a light blow from the hammer was necessary to overcome the friction in the ways, but usually the weight of the hammer was sufficient to the clay, when a few blows fastened the point in place.

Water was pumped out of the coffer dam by a centrifugal pump with 10-in. suction and 8-in. discharge. The pump well was situated in line with the forward end of the pumps, was 14 ft. interior diameter, 14¾ ft. deep below the lowest water, with a bed or floor of concrete 2 ft. thick. A wall with screens divided the well into 2-ft. parts. The intake and suction pipes were each fitted quarter turns and carried down to 2 ft. above the floor, where they were supported on iron framework resting on the floor. We will note in passing that at the test the combined pumps and condensers were unable to lower the water in the well to less than 8 ft. upon the floor. Fig. 1 shows arrangement of pipes, gates and by-pass.

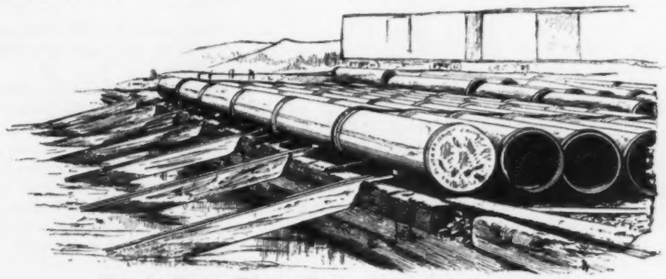


Fig. 3.—Racine Water-Works. Pipe Jointed for Laying.

At pump-well, as ordinarily used, the gates *D* and *E* are closed, and *A*, *B*, *C* open, the water flowing into the well at *A*, passing through the screens and out at *B*. If it is desired to draft from the intake direct, the gates *A* and *B* are closed and *D* opened; under this arrangement the well can be examined or cleaned. If anchor ice or other tobsruction gathers at crib, by closing *A*, *B* and *C* and opening *D* and *E*, the stand-pipe head of 200 ft. is thrown upon the intake through a 12-in. pipe connecting the force main with the cross in suction pipe.

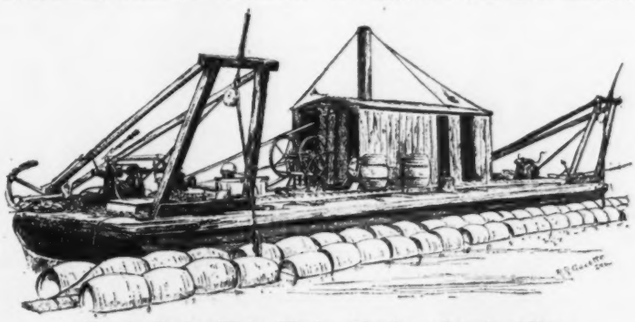


Fig. 4.—Racine Water-Works. Floating a Length of Pipe.

INTAKE PIPE AND RIVER CROSSINGS.

Although one is suction and the other force main, the method of laying is similar, and a description of one answers for both. This work was designed and executed by Messrs. Thacher & Breymann, of Toledo, Ohio. The intake is of 24-in. cast-iron pipe, with bell and spigot, as in street work, and was usually laid in sections of 6 lengths, or 72 ft. These were put together on ways carefully prepared on the dock, and the joints yarned, run and caked in the usual manner, head boards put over each end and covered with canvas securely confined around pipe. This is best shown in Fig. 3, as are also the sloping ways, adjusted and held in perfect surface by the rods passing through cap on piles in stream.

The method by which these sections are united is shown in Fig. 2. The spigot length of each section is put into a lathe and the bead turned off, and the pipe turned to a taper of about ⅜-in. in 4. These spigot lengths were all turned to a gauge, and were interchangable. This prepared spigot was inserted in the lengths intended for section hubs, leaving an end clearance of about 1 in. The joint was then yarned lightly and run, and the spigot removed. When laid, the 1-in. rods on each side were passed between the bolts in ears of clamps, and on drawing up, the inch left when the joint was run allowed the hub to be drawn on to the spigot, which expanded and swedged the lead in place, giving a joint as perfect as any others in the sections. With an internal pressure, the tendency is to push the lead tighter to place, both in the lead groove and on the taper spigot. That it made a perfect joint on the 24-in. river crossing was proved by tapping and putting on a pressure gauge, then, while the pressure was at 130 lbs., shutting the gates on either side the crossing and allowing the external pressure to drop to 70 lbs. Under this severe test, which was equally a test on two 24-in. gates, the pressure gauge was several minutes dropping to the normal point.

Fig. 3 shows a section of 24-in. pipe ready for loading, and Fig. 4, floating beside the working scow. If no water passed the canvas covering, there would be a buoyancy to the section of about 40 lbs. per foot; but to insure against mishaps, there are more than casks enough to float the pipe when filled with water. The casks are especially made for this work, as the ordinary barrel will collapse if submerged much beyond 25 ft. A pair of barrels standing on the scow illustrates how the pipe is carried. There are 2 rings to each cask, passed under heavy hoops; the ropes are made of uniform length with loop at each end, and are secured to rings by tarred ends which are cut when the casks are released. Before towing out into the lake the casks are lashed together over the pipe to prevent their shifting in case of sufficient swell to lift some portions of the section off its saddles.

The manner of laying can be best described from Fig. 4. Arrived at the proper position in the lake, 4 anchors are carried out some distance away, and the scow hauled approximately to place, the pipe line being marked by buoys and ranges ashore. The diver then goes below and examines the spigot of the last section laid; if earth or mud is around it the centrifugal pump is started, and a flexible suction lowered to the bottom, the lower end applied to the vicinity of the joint and the material sucked out.

The pump stands so near the surface of the water that but a small lift, plus the friction in hose and pump, is all that is required to get a powerful current. As soon as all is clear around the spigot, the headboard is removed, the section filled with water, and a sufficient number of casks cut loose to overcome the buoyancy, not more than 700 or 800 lbs., usually being thrown upon the derricks; the section is then lowered ready to place, the headboard of spigot cut loose to drift above, and the section further lowered nearly to position; the section now hanging in deep water, the ropes supporting it from plumb lines and the scow is moved so that the pipe is placed accurately on line of buoys and ranges; the pipe is then lowered till the hub just touches the spigot, when the bolts are entered in the clamps and the nuts drawn tight enough to make sure of retaining the hub on spigot; the outer end of pipe is then slacked away to within a couple of feet of the bottom. If any obstruction is met with, preventing this lowering, which is observed by knots on the falls, signal is given to the diver below and an examination is made. If the obstacle is anything which can be removed by pumping, that is resorted to; but if the solid earth shows that the excavation has never been made, then the two sections are disengaged, the pipe raised to the surface and the dredge recalled to complete the work. It is seldom, however, that this last has to be resorted to. When examination shows everything favorable, the nuts on each side are turned up as tight as possible, alternating from side to side of the pipe every 10 quarter turns to preserve an equal strain. When all is drawn taut, the outer end is slacked entirely away and further examination is made. If the section is found properly resting on the bottom, the lashings are cu which hold the casks in place and they rise rapidly to the surface, sometimes jumping 2 ft. out of water; occasionally the pipe will bear so heavily on the bottom that the buoyancy of one cask is not sufficient to draw the ropes from underneath, in which case the lashing is cut on the other side and the rope left at the bottom. The best day's work was made in June of this year, when 4 sections, or 288 ft., were laid in one day, the depth at that time exceeding 45 ft. of water.

Connection was made with the shore end last December by cutting through the coffer dam and pushing through a short section with a head on it. The dam was then made tight around the pipe and the coffer dam pumped out, when the two ends were brought within about 8 ins. of each other, and carefully placed for line and grade; a flanged sleeve was then made, about 2 ft. long, with a projecting rib about 4 ins. from each end, the headboard removed and the sleeve put in place under water, and the joints partly calked with lead pipe, but owing to the severity of the weather (below zero), the coffer dam was again pumped out and the calking finished in open air.

Upon the completion of the intake this summer, a tee and upright 8 ft. above the bed of the lake was placed at the end, and this surrounded by a submerged crib, 18 ft. square on the base and 10 ft. high, in 9 compartments, the center one of which surrounded the upright. The timbers forming this crib were halved and doweled solid together, except the upper 3 courses, which were left 2 ins. apart, the top was covered with timber and plank except the center, which was covered with boiler plate punched with 1-in. holes. The crib was filled with sufficient stone to sink it while buoyed up with casks in the same manner as the pipe, when it was lowered and surrounded with 50 cords of stone.

Land Reclamation in Egypt.

The Egyptian Lakes Reclamation Co. has been incorporated in England to acquire a concession granted by the Egyptian Government in March, 1887, for reclaiming and owning the lands known as Lake Aboukir, near Alexandria, comprising about 31,000 acres, together with the works and machinery with which the reclamation is now being rapidly carried out, and the caution money deposited under the concession. The reclaimed lands will be exempt from taxes until Dec. 31, 1890, and then will be subject only to moderate and reduced rates during the subsequent 10 years. The lands, composed of Nile alluvial soil, extend to within 4 miles of Alexandria, and are practically suburban. They were cultivated and populated from very early times until towards the end of the 18th century, when, owing to an embankment bursting during a storm, or to damage done during military operations between the French and English armies, or from both causes combined, they were submerged (being slightly below the level of the Mediterranean). The sea has for many years been excluded by a solid and improved embankment, while that of the Rossetta Railway provides an inner line of protection, thus securing absolute safety. Through evaporation the sea water has disappeared, leaving a saline deposit, but the lands have, during part of the year, been covered to a mean depth of about 12 ins. with fresh water, coming from adjacent lands during high Nile. The present reclamation of the so-called Lake will restore for industrial occupation 31,000 acres of fertile soil which formerly contributed largely to the prosperity of Alexandria and the surrounding country.

On the north and east the sea and the Rossetta Railway and on the southwest the Mahmoudieh canal, with the Cairo Railway running parallel, give ready access to Alexandria and its harbor. Occupying a narrow strip of sands between the sea and the lakes, the city of Alexandria is practically destitute of arable land in the immediate vicinity, excepting some scattered gardens; and the entire supplies for the rapidly increasing population of 250,000, are mostly derived from a distance on the southeast, beyond the lands now being reclaimed. It is therefore stated that, with the advantages of practically virgin soil, close proximity to a great city and seaport, and abundant facilities of communication, the lands as reclaimed must necessarily become valuable. As regards value, a special report made in February, 1888, by M. BURNIER, Expert Agronome for the mixed and native courts, on the rentals now being paid for lands in the vicinity of Alexandria, adjacent and similar to, and some of them recently reclaimed under like conditions to those of Aboukir, shows that $25 to $40 per acre is a usual rent. Purely agricultural lands in the Delta proper let at $5 to $10 per acre for low to common; $15 to $25 for medium to good, and $30 to $75 for suburban lands.

The reclamation works, designed by Mr. JAMES ABERNETHY, M. I. C. E., are already far advanced. They consist of main and subsidiary drains, converging to a reservoir made on the north shore of the lake. The washing of the surface soil and cleansing it from saline deposit by Nile water from the Mahmoudieh canal has already commenced over about 12,500 acres on the northern portion, and the water from this area is now being pumped into the sea by means of two of the most powerful Gwynne's "Invincible" pumps lately erected. The present pumping will probably be completed by May. At high Nile next September the whole area will be subjected to this cleansing and fertilizing process, after which it will be pumped dry, the irrigation completed, and the land let or sold by the company as may be deemed most desirable.

The Aboukir Company, (the vendor), has fixed the purchase money for the concession and lands to be acquired, with all the works already completed or in progress, and all the machinery and plant connected therewith, at the sum of $1,500,000 for which consideration it is also to furnish the Reclamation Company in cash with $1,000,000 for working capital, and $150,000 to complete the reclamation, which sum is ample for the purpose. Mr. ABERNETHY has reported as follows:

"I estimate the cost of completing the remainder of and maintaining the works for 6 months at the sum of £150,000 which is fully ample to cover all contingencies."

Mr. ABERNETHY is the Engineer of this company.

Improved Street Car Rails.

The great interest which the question of improved street car rails has excited recently, has led us to describe as far as possible every type of rail which is in use abroad, with the object of reducing the interference with street traffic to the minimum. As is now well known, the center bearing street car rails in almost universal use in New York, and to a large extent in other cities, were designed with the express object of interfering with the normal street travel as much as possible, and is admirably adapted to that purpose, being of inverted ⊥ type, the center of the rail being the bearing head, and the two flat flanges at the side being admirably adapted to cause two ruts to wear in the pavement on each side of each rail, and so cause teams to avoid whenever possible coming anywhere near the track. According to the testimony of Mayor HEWITT, the great iron firm with which he was formerly connected designed this rail with this express object on the application of one of the street car companies, and it has been brilliantly successful. Not only does it make the streets in which the tracks lie very unpleasant for teams, but they are very frequently a source of danger to pedestrians. It is within our own knowledge that a few days since a lady caught her foot in one of these ruts in crossing one of the crowded streets, and came very near losing it. That no people but the Americans would tolerate long such a corporate abuse is strongly indicated by the fact that no other people do tolerate it, the street car rails throughout Europe being principally of one or the other of the types we describe.

The objections to the side bearing rail, which is almost universal in this country where the center-bearing rail is not used, are only about half as great as to the center-bearing, but are still very great, and it is nowhere used in Europe to any considerable extent. It causes ruts to wear, and makes it very difficult for teams to pass over, whereas in Europe, track of the types we illustrate is passed over by teams with perfect ease.

There is one special difficulty here, to be considered in introducing any of these types, that the minimum width of carriage tire is considerably less here than abroad. For example, many of our light carriages have tires of an inch or less in width, which might easily catch in a rail of the type shown in Fig. 2, for example, and break the wheel. But these are a very small minority of the vehicles; they can avoid all danger by simply keeping off the track; they must run almost exactly parallel with the track to get into any danger; and what remains of the danger can be eliminated by narrowing the gap shown in Fig. 4, without interfering with its efficiency as a street car rail, while in the other styles the same difficulty does not exist to any objectionable extent.

The first use of these foreign types of rails on a large scale in this country was on the new "Liverpool rail" track of the West End Co., of Boston, as illustrated in our issue of Aug. 20, 1887. That track has a rail 7 ins. high, ½ in. web, 6 ins. bottom flange, 90 to 100 lbs. per yd., with 4×6 ins. cross-ties, 7½ ft. long, every 7½ ft., and with a continuous bar of concrete for the rails to rest on, 18 ins. wide by 8 ins. deep. The pavement is of Belgian blocks, laid in mortar. Iron tie-rods, 2½ × ½ in., having ¾ in. screw ends, alternate with the ties, being also 7½ ft. between centers.

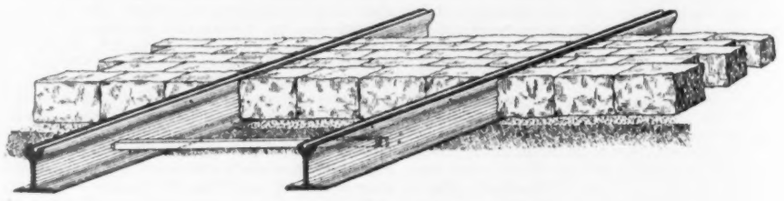


Fig. 1.—The Phœnix Rail Track.

In England and its colonies as well as in South America, there is in use the Phœnix rail or "Liverpool" laid for the most part in the manner shown in Fig. 1. Over 10,000 tons of these have been sold to England by foreign manufacturers, besides those made at home. There is a great variety of weights and sections according to whether the rails are brought in use for horse or steam cars, light or heavy traffic.

The lightest and cheapest weighs 60 lbs. per yd., 120 lbs. weight of track when complete, and is shown in Fig. 2. The cost is $29 a ton, with 94¼ tons to the mile, or $2,780 a mile without duty delivered in New York. This rail is in use in Coblentz, Germany; Brisbane, Australia, and in Königsberg, Prussia.

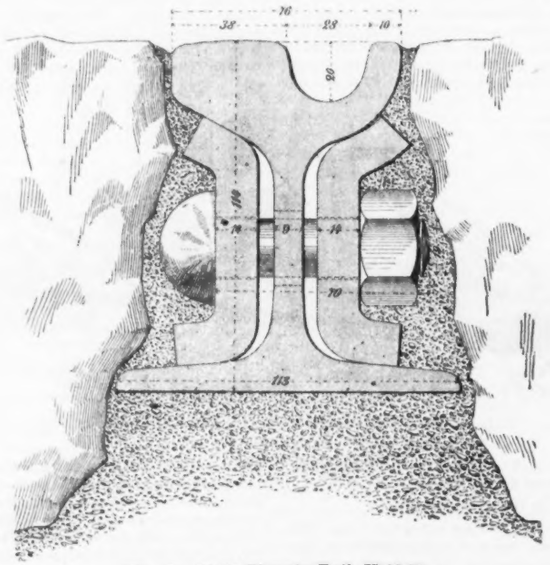


Fig. 2.—Light Phœnix Rail. Half Size.
(Tie bars 0.39 x 1.58 ins., 7 ft. 4½ ins. apart.)

The latter place has a very severe climate, the winters being much worse than those of New York, yet even with these small rails, laid directly on the sand underlying the paving, as shown in Fig. 2 (about 4½-in. base and height) no trouble has arisen from heaving or irregular settlement after years of use, and the same is still more true of the larger styles. In Königsberg some of this track is even used by locomotives.

The rails range all the way up to 69 lbs. per yd. or 194 lbs. per yd. of track. Fig. 3 shows the larger size, as used in London by the North Metropolitan Tramway, and by the Street Tramway Co. in Belfast. This pattern runs 152½ tons in a mile, costing $27½ or $4,290 per mile, without duty, delivered in New York.

According to what seems to be the admitted result of continental experience, one of the best, but also one of the most expensive rails is the composite Haarmann twin rail shown in Fig. 4. It is extensively used in Vienna and Berlin.

There are larger and smaller sizes, but the great Berlin Tramway Co. recently ordered a large lot exactly like Fig. 2 in general construction but lighter, costing $3.25 per yd. $3,930 per ton, or $5,725 per mile, there being 145.66 tons in a mile. The weight of rail per yard is 58.84 lbs. One yard of track weighs 184¾ lbs. There are in all Europe some 200 miles of this kind of track, of all sizes, if we are correctly informed, although we do not vouch for the precise figures.

The outer rail that carries the wheel consists of two halves riveted together, the joints being broken. The joints are said to be quite imperceptible. The wedged-shaped filling piece secures an even pressure over the entire base. The inner rail may be called the guard rail, because it prevents the car from coming off the tracks, should there be anything lifting out the wheel on the opposite side, as well as provides for smooth passage of teams.

The rails for the Fig. 4 type weigh 127 lbs. per yd., the track complete is 197 lbs. per yd. The cost of this type is $41.33 per ton to the mile or $6,489 per mile, 155¼ tons, without duty, delivered in New York.

There are also largely used plain Haarmann twin rails, as shown in Fig. 5, like Fig. 4, except that the main rail is not composite, which seems to us a preferable form. The lightest and cheapest form is that engraved in Fig. 5, weighing 101 lbs. per yd. of track, or for the track complete, 114 lbs. per yd. This costs $36.50 per ton, 90 tons to the mile, or $3,700 per mile, without duty, delivered in New York. These rails are similar to the Paris rails and a model has been exhibited for sometime in the office of Mayor HEWITT. They are largely used in Vienna, Berlin and Frankfort.

The Haarmann as well as the Phœnix rails are sunk in the street so that the top is flush with the pavement, giving no occasion for wrenching of truck wheels or accidents by wagons sliding along the track sideways and bumping into one another. There is practically no repairing necessary to either of them as proved by from 7 to 10 years experience.

A section of tire used in Hamburg for locomotives of 9 tons weight, has a flange only 0.6 in. thick, although the trains run at 10 miles an hour, and it

has proved successful. All street car flanges are for the most part thin, and there would seem to be no reason why the opening for them should not be made too small for the narrowest buggy tires to enter.

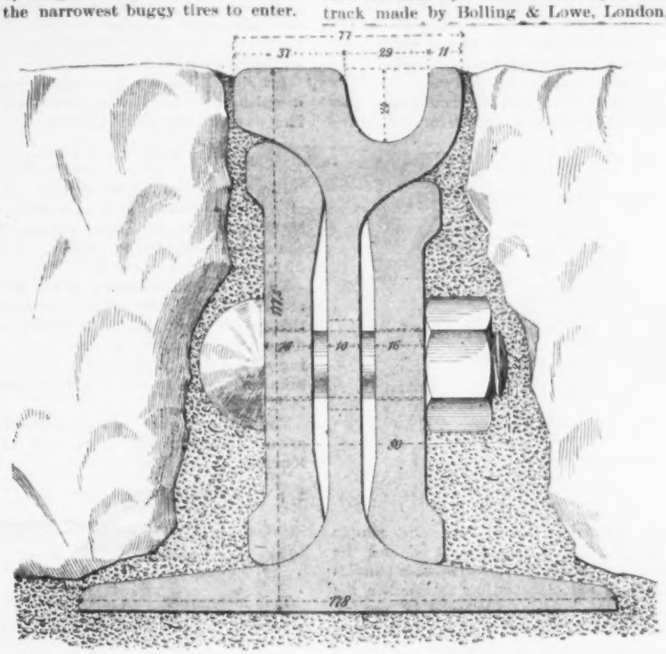


Fig. 3.—Heavier Phœnix Rail. Half Size.
(Tie bars 0.39 x 3.15 ins., 9 ft. 10 ins. apart.)

All the rails illustrated are of steel and all give a broad bearing surface for wagon wheels, which, as the Director of the Frankfort Street Railway has lately stated, contributes considerably toward maintaining the pavement in good condition.

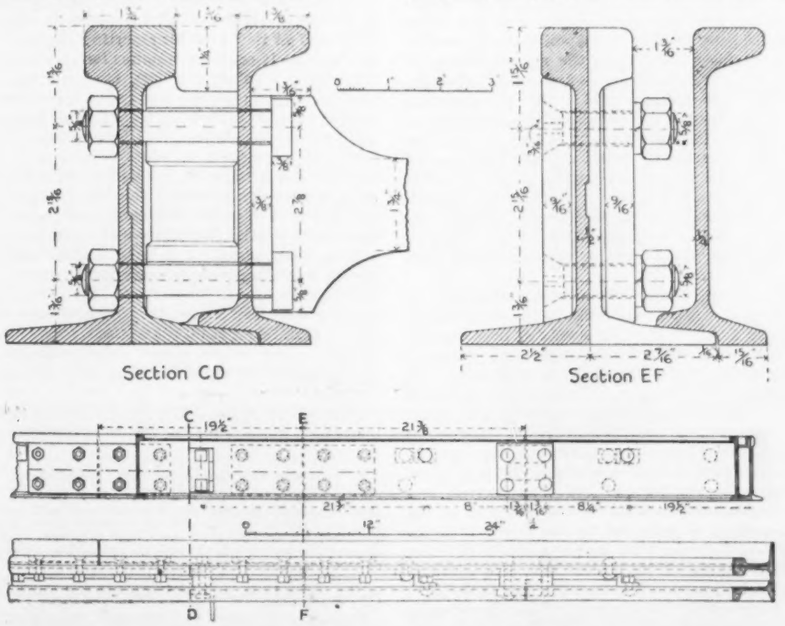


Fig. 4.—The Haarmann Composite Twin Rail.

If any foundation but sand is used there is found to be none better than concrete, nor are wooden ties found useful for any of these rails. Only strong straps and flat iron tie-rods are used to keep the rails in place. This makes the laying of the tracks cheaper than with our own system. All that is found necessary with the broad based rails is to put coarse sand underneath and ram it down under the rails. The rails are even run over in some cases before doing this. The surface is claimed to be better preserved than with any form of wooden substructure, and as well as with concrete.

For much of the above information we are indebted to Mr. GEO. BERNA, of 157 Bank St., New York, who is acting as agent for some foreign manufacturers to introduce their types of street car track into this country. The various styles of street car track made by Bolling & Lowe, London, are described below, from information given us by E. M. Cole & Bro., of New York.

The first style, which has been largely used on road railways in Italy where the track is partly in the country and partly in towns, consists of a 35 lb. ⊥-rail, with a guard-rail whose section is like the half section of the ⊥-rail of the same general type as Fig. 5. Cast-iron distance blocks with bolts passing through rail, block and guard-rail hold the latter in position thus forming a grooved tramrail. The price quoted per mile, including joints, cast-iron blocks and spikes, is about $4,000 for rails weighing 35 lbs. per yd. and guard rail 24 lbs. The guard-rail is used only in towns, and the track is supported on wooden ties.

The second type (Aldred & Spielman's patent) has the rail made in halves, which are reversible and are fixed in cast-iron chairs 3 ft. apart, by wooden keys. There are no bolts or loose parts, and the rail can be lifted out without disturbing the substructure. The cost of 62-lb. rails, with chairs and wooden keys is approximately $4,800 per mile; the weights being, rails 98 tons, chairs 34 tons, lag-screws 2½ tons and 3,700 wooden keys.

The third style, used in Oxford and Kurrachee, is a Bessemer steel rail of the inverted ∩ bridge section, with a groove in the top: the tread of rail is 1¼ ins., the groove 1 in. wide and the guard ½ in. thick.

These rails are laid on a bed of concrete and are joined at the ends by cast-iron chairs about 9 ins. square. A wrought-iron gauge tie, with ends turned up and passed into slots in the chair, keeps the rails to the correct gauge. The cost of 70-lb. rails with fastenings is about $5,300 per mile, the cast chairs weighing 6 tons. The pavement, as well as the rails, rests on the concrete.

The fourth style, used in various parts of England and the Continent, is a steel rail with grooved top designed to rest upon longitudinal wood sleepers to which the rail is fastened by ∪ shaped dog spikes 3 ft. apart. The ends of the longitudinal sleepers are placed in cast-iron shoes 9 ins. long; the sleepers are tied together transversely by ¾ in. tie rods 6 ft. apart. Sole plates are used at each rail joint. The cost per mile for 48-lb. rail with fastenings is about $3,700.

The fifth style, entirely of iron and steel, has steel rails of the general section of Fig. 2, resting upon steel sleepers, 3,520 per mile, weighing 56½ tons per mile, placed longitudinally, resting directly on sand, to which the rail flange is fastened by wrought-iron pins and cotters. The rails are

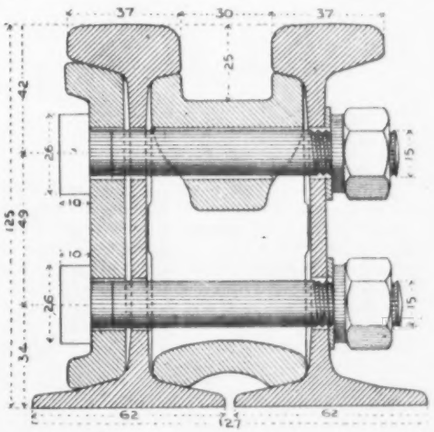


Fig. 5.—The Haarmann Twin Rail.

jointed by ordinary fish-plates, and kept to gauge by wrought-iron tie bars. The price per mile is $6,000 for 50-lb. rails and $6,600 for 60-lb. rails.

The sixth style has rails similar to the fifth, secured to transverse steel sleepers, instead of longitudinal, 3 ft. apart, by clips and bolts. The price per mile is $5,200 for 60-lb. rails. It is made for 45, 55, 60 and 70-lb. rails.

The seventh style, which has been adopted by some South American companies, has steel rails with grooved top but no base, resembling the upper half of the section in Fig. 2, which rests in recesses in hollow cast-iron chairs placed 3 ft. 6 ins. apart, where they are fastened by cast-iron wedges. The chairs extend up to the surface on each side of the rail, are bedded in concrete, and are checkered on top to prevent horses slipping. The price per mile, for 36-lb. rails, is about $4,800. It is also made for 30-lb. rails; 60 tons of cast chairs per mile are used.

A modification of this type has the same style of rails and chairs, but the latter are flanged at the base. The price per mile for 36-lb. rail is $6,000. Track of this type is extensively adopted in England. Neither of these styles seem to us to have much in their favor except the form of the rail top.

This includes all the kinds of street car track made by leading manufacturers, and it will be observed that our American styles of rail are conspicuous by their absence. We might imagine that one reason was our severer winters, but when we remember that many European towns which use these unobstructive rails have worse winters than we, and that the first American city to move in this direction is Boston, with about our worst winter

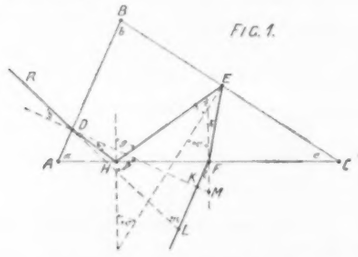
climate, we are unable to attach much force to this supposed cause. The real reason, we fear, is that the rights of the public are more insisted upon abroad than here. Reform is urgently demanded.

Angle Prisms.

BY E. A. GIESELER, C. E.

The instrument generally used in this country for laying out angles of frequent occurrence, such as 90 and 60 degrees, is the well known angle mirror, which is constructed on the sextant principle, and was invented during the last century by ADAMS, a London optician. Angle prisms are rarely used, the impression apparently prevailing that their handling is complicated and inconvenient. But this impression is certainly an erroneous one. The handling of the angle prisms is quite as simple as that of the ordinary reflecting instruments, and besides they possess the undoubted advantages of being less bulky and of never losing their adjustment.

Angle prisms are made in various shapes, but the ones mostly in use are triangular ones. Their characteristic feature is, that the ray of light after being twice reflected and twice refracted during its passage through the prisms upon its emerging from the same is diverted from its original direction to the constant amount of the larger of the two refracting angles of the prism.



In order to find what conditions must be fulfilled to obtain this result let us assume the triangle *A B C* in Fig. 1, to represent the cross-section of a triangular prism and the heavy line to indicate the path of a ray of light *R*, entering it at *D* and leaving it at *F*, after having been successively refracted at *D*, reflected at *H* and at *E* and finally refracted at *F*. The light broken lines are perpendiculars to the sides of the triangles, erected at *D*, *H*, *E* and *F*, in order to show the various angles of incidence of refraction and of reflection; the line *D L* is the prolongation of the ray *R*, the angle *m*, which it forms with the emerging ray is therefore the change of direction caused by the passage through the prism.

Now according to the well known laws of refraction we have

$$(1)\quad \sin.\ a = n\ \sin.\ e$$
$$(2)\quad \sin.\ l = n\ \sin.\ k$$

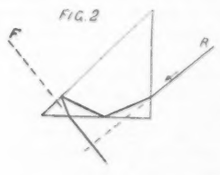
n being the coefficient of refraction. According to simple geometrical principles we further obtain from the figure the following relations between the various angles

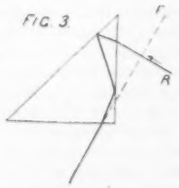
$$a = e + g$$
$$g = e + h$$
$$h = e - k$$

from which we find by substitution,

$$e = a - 2e + k.$$

If now we assume $a = 2e$, that is if we make one

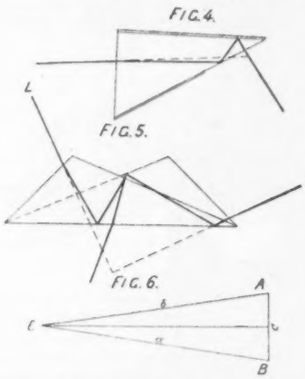




refracting angle twice the size of the other, this equation renders $e = k$, from which follows according to equations 1 and 2, $d = l$. For the two triangles *K F M* and *D K L* besides these two angles, the two at *K* are also equal: consequently the third angles must also be equal. The angle *M* is equal to *a*: consecutively we have $m = a$ that is, the desired result of the change of direction of the ray being equal to the larger of the two refracting angles, will be obtained by making this larger one twice the size of the smaller one.

In our demonstration the ray was first refracted by the *larger* of the two refracting angles of the prism. But the change of direction will remain the same if the order is reversed, in proof of which it is only necessary to consider *L F* as the entering ray and *D R* as the emerging one, which assumption manifestly will not alter the relation of equality existing between the two angles *m* and *a*.

On this principle, which was first demonstrated by Prof. BAUERNFEIEND, of Munich, the form of all tri-



angular angle prisms is based. The most simple one is the prism in which one angle is 90° and the two other angles are 45° each, and with which angles of 90° can be laid out. According to whether the larger or the smaller angle is employed is first replacing angle there will be two different ways in which the ray passes through the prism. In Fig. 2 the right angle is the first refracting angle, while in Fig. 3 it is the angle of 45°, the resulting change of direction remaining the same, viz., 90°. It will be seen that in both cases the ray emerges near the apex of the second refracting angle. This is always the case, and in order to perceive the desired image, the eye of the observer must therefore look into the prism near this point. If the angle of 90° is employed as first refracting angle, then the prism should be held so that its hypothenuse points toward the object from which the ray emanates. If the angle of 45° is employed as first refracting angle, then the prism should be held so tha the incoming ray stands about at right angles to the hypothenuse. The fact that the correct image is seen is easily established by giving the prism a slight turn around its handle as a vertical axis; in doing so the correct image will *stand*, that is, it will not change its location with reference to an object seen directly over the prism in the direction of the broken line; all the other images produced by the prism will turn with it.

After having found the correct image, for instance, of a flag-pole standing in the direction *R*, then the flag-pole *F* in the hands of the assistant, which is seen directly over the prism in the direction of the broken line, is lined in so as to coincide with the image of the first flag, when both will be in the sides of a right-angle, the apex of which is the point of observation. If these directions are observed no difficulties will be found in the use of angle prisms.

Another form of them is shown in Fig. 4; here the two refracting angles are 60° and 30° respectively, and angles of 60° can therefore be laid out with it: the ray traveling as indicated by the heavy line. In order to exclude the false images and thus to facilitate the finding of the correct one, this prism is boxed as indicated in the diagram, only those parts of it being visible that are required for the entering and the emerging of the ray. With this prism the smaller or the larger angle is to be employed as first refracting angle, according to whether the first flagstaff stands to the right or to the left of the observer. A third very ingenious form, consists of two congruent prisms, one placed above the other as shown in Fig. 5, the angles in each being 112½°, 45° and 22½°. By using either the upper or the lower prism by itself, angles of 45° are laid out, but by bringing the image of the right hand object *R*. in the lower prism to coincide with the image of the left hand object *L*, in the upper prism as shown in Fig 5, right angles can be laid out. This instrument is preferable not only because it contains the angle of 45° and of 90° but also because in laying out the latter the two *images* are brought to coincidence, which can be done more readily and more accurately than bringing an *image* and an *object seen directly* to coincidence.

Another form of angle prism has been devised to serve the same purpose as PRATT'S range finder, that is to determine, in a simple way, the distance of an inaccessible point.

Let *A B C*, Fig. 6, be an isosceles triangle in which *a* and *b*, the two equal sides, are each *m* times as long as *c*, the base; thus we have

$$cos.\ A = cos.\ B = \frac{c}{2a} = \frac{c}{2mc} = \frac{l}{2m}$$

If we make $m = 20$ we obtain: $cos.\ A = 0.025$ or $A = 88° 34'$. That is, if the two angles *A* and *B* are 88° 34' each, thus the distance from either *A* or *B* to the inaccessible point *C* will be twenty times the distance between *A* and *B*.

To lay out this angle a prism of the following angles is needed: 88° 34', 44° 17', and 47° 9', and with this prism the angle *A* is first laid out by fixing a flag somewhere in the direction *A B*; thus, by moving on this line, the point *B* is found the connection between which and *C* forms the same angle with *A B*.

The accompanying cut is a perspective view of the prism shown in Fig. 5, as sold by the firm of KEUFFEL & ESSER, of this city.

This instrument is a very neat little device, and would undoubtedly be of great use in the field, and its extremely small size and simplicity are strong points in its favor.

Form for Reports of Bridge Inspectors on the Buffalo, Rochester & Pittsburg Railway.

We have received from WM. E. HOYT, Am. Soc. C. E. and Chief Engineer of the Buffalo, Rochester & Pittsburg Railway Co., a copy of an excellent form used on that road for reporting the condition of bridges. It contains columns for giving date of inspection, number of bridge, kind of bridge, and comments upon: action under trains, approaches, re-railing guards and outside guard rails, alignment and surface, ties, lateral and longitudinal braces, stringers, caps, posts in bents or long piles, sills, sub-sills and foundation, piles, planking and bolts; these for wooden trestles. For iron trestles there are spaces for comments upon iron posts, iron bracing to trestles, bed plates and expansion plates and masonry piers. For truss bridges and iron girders comments are to be made in the report upon chords, main braces and counters, suspension rods in Howe trusses, floor beams, floor beam hangers, track stringers and floor beam connections, joint castings, bed-plates and rollers, rivets, paint and masonry. At the foot of the form there is a space for general remarks.

On the back of the forms are full instructions to inspectors, which we think will be of interest to our readers:

ORDERS FOR THE INSPECTION OF BRIDGES.

The Inspector must examine every part of each structure with the greatest thoroughness and care. If serious defects are discovered, a report must be telegraphed immediately to the Chief Engineer, and the General Superintendent must be notified by telegraph so that a slow order may be issued.

A complete record of each inspection is to be written on the blank form, and forwarded to the Chief Engineer every week.

The action of bridges under passing trains should be observed as often as possible. There should be no swaying of the bridge from side to side. The trusses should keep in perfect line, without twisting or sagging, and the deflection should be slight under the heaviest loads.

The condition of the approaches must be carefully observed. The ties on the bank near the ends of bridges should be firmly bedded and kept in good surface by the trackmen, so as to cause no shock to trains coming on or off the bridge.

See that water barrels and pails are kept on all large wooden bridges and trestles, and that the barrels are filled with water except in winter.

See that chips are not allowed to remain on any part of the bridge where repairs are made. All old timber, brush, driftwood and other inflammable materials are to be cleared out from under bridges and trestles of all kinds, and removed to a safe distance.

WOODEN TRUSSES.

In wooden trusses, the condition of the chords about the keys and clamps, and around the angle blocks, must be particularly examined to see that the joints

are not opening and that there are no evidences of decay in the timber.

The clamps must be sound and strong, and have a firm hold of the timbers they connect.

The ends of the main braces and counter braces must have a full and true bearing on the angle blocks. Any sliding from their proper places or splitting of these timbers at the ends is to be carefully looked for.

See that there are no cracks in the angle block castings.

Floor-beam bolts must have the nuts tight and screwed to a proper bearing. Care must be taken to see that washers or bearing plates on these bolts do not cut into the chords or floor-beams.

The chord bolts must be kept well tightened.

Main suspension rods must have an even tension. No rod must be allowed to become tighter or looser than the others beside it at the same panel-point.

The struts in the lateral bracing must be brought to a firm bearing on their blocks, but the rods must not be over-strained.

Inspect thoroughly timbers resting on the bridge seats, and see that cinders, dirt and rubbish are carefully cleared away from them.

TRESTLES, CATTLE PASSES, OPEN TIMBER CULVERTS, ETC.

Wooden trestles are to be examined both from the top and at the bottom, so that the condition of every part of the structure can be determined.

All joints where one timber has a bearing on another must be particularly looked after for evidences of decay. Ties, stringers, caps, posts and sills must be sounded with a hammer at all places where inside rot is likely to take place, and borings with a small bit are to be made in doubtful cases to show the condition of the timber under the surface. These borings must be in an oblique, upward direction, so that water may not run into the test holes.

Examine piles, sills and sub-sills to see that every bent has a proper bearing on its foundations.

If bolts or nuts are missing, give the number and size in your report, so that others may be sent at once to supply the deficiency.

See that all bents are straight and upright. Test this with a plumb-bob in trestles over 10 ft. high.

There must be no recesses in any part of the structure where water can collect.

IRON BRIDGES.

See that the bearings of the trusses or girders upon the bed plates are in perfect order, and that all cinders and dirt are cleared away from the bridge seat. Be sure that the rollers have free movement, and that they are squarely on the bed plates, in true line with the axis of the trusses. Look carefully for defects in the anchor-bolts, rollers or roller frames, and in the bed plates and bearing plates above the rollers.

Examine the end castings and all joint-boxes for cracks or flaws.

See that floor-beam hangers have a true and full bearing over half the circumference of pins, and that they show no signs of failure by breaking or stretching. If they are of the old loop pattern, be sure that the nuts are not working loose under the floor beams. Keep reference marks of white paint on every hanger nut and the adjacent surface, to detect any movement of turning. The same precaution should be taken with the nuts on the chord-pins.

If floor beams are riveted to posts, or stringers riveted to floor-beams, examine these connections with the greatest care. Be sure that the rivets are perfectly tight and sound, and that the web and flanges and plates at the joints show no signs of tearing or crushing or of being battered, and that there are no indications of the rivets shearing. If one or more loose rivets or other defects, however slight, are found in these connections of floor-beams or stringers, they must be reported by telegraph immediately.

Test all riveted work frequently by sounding the rivets with a hammer, to detect any that may have become loosened or fractured.

See that web-plates show no signs of buckling and that they are free from scale or rust.

In the main trusses, test the bearings and tension of all eye-bars and counters by pulling them from side to side, and by shaking them. All members that are side by side in one panel must show the same degree of tightness or tension. If there is more pull on one bar than on the corresponding ones beside it, the fact must be reported at once, since this indicates a dangerous condition to the truss.

Great care must be taken that the counter rods are not too tight. If found to be too loose, they may be screwed up simply to a firm bearing, but under no other circumstances is the adjustment to the trusses to be changed, unless special orders are given to this effect by the Chief Engineer.

The horizontal lateral bracing and the sway bracing must be examined particularly. The tie-rods must be sufficiently tight to bring them into action to resist side strains, and it is important to see that they are not strained beyond that amount.

All parts of the bridge must be well protected by paint.

IRON TRESTLES.

See that the posts of iron trestles are straight and true, and that there is no distortion in any part of the structure.

Inspect the bracing carefully to detect any signs of buckling in the struts.

The expansion plates and rollers must be particularly examined to see that there is free motion for the bottom of the sliding posts in each tower. Be sure that all anchor bolts are securely in place, and that they have not been bent or fractured or injured in any way.

MASONRY.

Examine all stone work from bridge seats to foundations of piers and abutments. If there is any probability of the current of the stream scouring near the foundations, soundings must be taken with long rods to ascertain the condition of the rip-rap or other material about the submerged parts of the masonry.

See that there are no indications of settling or bulging in piers or abutments. Cracks in the stones or at the joints must be carefully noted and reported, with full particulars of their size and extent.

If there are defects in the pedestal stones, or anywhere about the bridge seats, immediate notice must be given by telegraph.

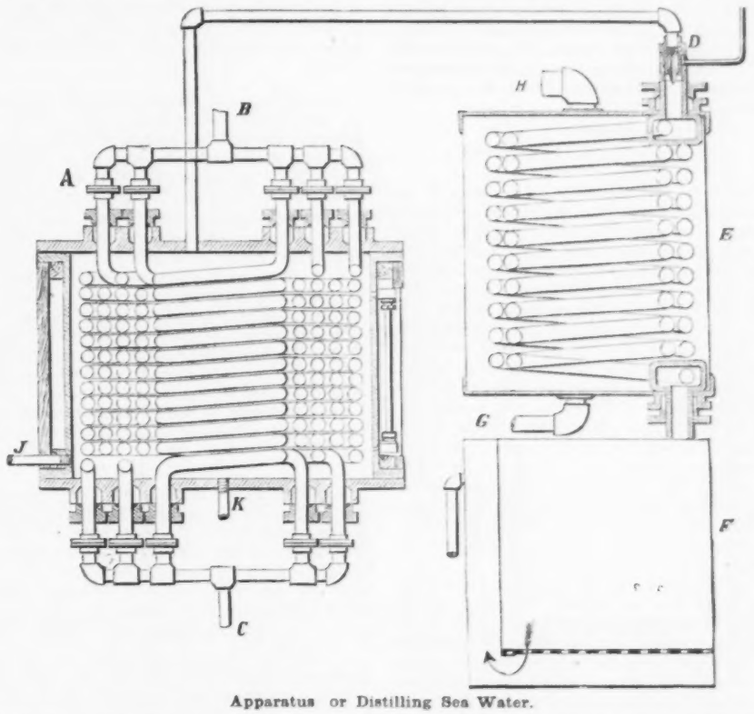
The condition of the pointing of the masonry must be observed, especially about the coping and the upper course.

See that the parapet walls have not been disturbed by frost, and that dirt and gravel are not allowed to run over on to the bridge seats.

Fresh Water Distilling Apparatus.

We illustrate from the *Army and Navy Journal* an improved apparatus for distilling fresh water for use on shipboard, which dispenses with the donkey boiler frequently employed and uses steam from the main boiler for evaporating.

Steam from the main boilers is introduced at *B*, which heats the coils; the condensed water drawn



Apparatus for Distilling Sea Water.

off at *C*, is conveyed to the hot-well and is used again in the main boilers. Sea water is introduced at *J*, and is boiled by the heat of the coils, the steam from which passes through the aerator *D*, where it is aerated, and then into the condenser *E*, where it is condensed. The water thus aerated flows into the filter *F*, from which it is delivered to the ship's tanks. Sea water enters the condenser at *G*, and is discharged at *H*, which cools the coils and condenses the steam. A blow off cock is placed at *K*, and a suitable salinometer pot is provided.

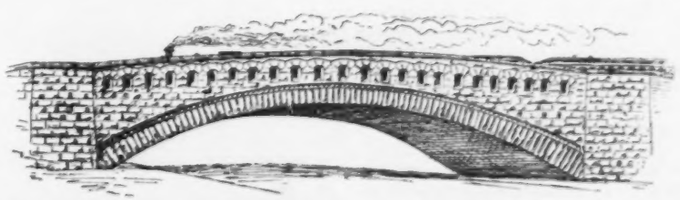
The apparatus gives a very pure water, as in evaporating it is at no time subjected to the direct action of the furnace, nor contaminated by oils from the engine, as is sometimes the case when steam is taken directly from the main boilers and condensed. The apparatus is also commended for its simplicity, requiring less oversight than a separate donkey boiler, and it also occupies much less space.

In a recent test at the Davidson Steam Pump Works, Brooklyn, of one of these machines, intended for the Gunboat *Petrel*, an evaporator with 52 sq. ft. of heating surface, and 51 lbs. pressure in the coils, worked at the rate of 900 galls. per day.

WHAT has become of the locomotive with the hundred or more flat spots on each tire which was built down Boston way a few months ago? When are we to hear its cheerful hippety-hopping along the rails?—*Railway Master Mechanic.*

Proposed Stone Arch at Springfield, Mass.

The accompanying sketch of the proposed stone arch which is to carry the Boston & Albany tracks over Main Street at Springfield, Mass., is of interest as evidence of results in still another city from the prevalent agitation for the removal of grade crossings. And perhaps of still greater interest as an example of the result of setting an architect to design an engineering structure. If the view from which our sketch is engraved correctly represents the architect's design, it is plain on its face that the proposed structure will be a piece of masonry of extremely ugly appearance; and we trust the architects, Messrs. SHEPLEY, RUTAN & COOLIDGE, of Brookline, Mass., will see fit to amend some of its worst features, for the sake of their own reputation as well as in the general interests of good taste. The principal fault of the design is the extremely high parapet, which the architects were probably obliged to put on in deference to a popular demand that the moving trains should be hidden from the street on account of frightening teams. But it seems as if it might have been much more artistically treated than has been done in the present case. With all respect to the artistic advantages of stone, it seems that an iron structure of reasonably good design would have made a more creditable appearance than does this.



Proposed Stone Arch of Boston & Albany Railroad over Main St., Springfield, Mass.

The arch is represented as it will appear from the front of the Massasoit house. It is to be of light granite. The roadway passing beneath the arch is 50 ft. wide between the curbs with 8½ ft. sidewalks. The clear headway at the center of the arch is 14 ft. and from the soffit line to the top of the parapet is 14 ft., 6 ins. The radius of the intrados is 79 ft.; of the extrados 123 ft., 8 ins. The top of the track rail is 10 ft. below the top of the coping, leaving 4¼ ft. between the soffit of the arch and the top of the rail. Of this space 1 ft. is occupied by ties and rails and 3 ft. by masonry, leaving 6 ins. for

ballast under the ties, which is expected to deaden the noise considerably. At the center of the arch the face voûssoirs are 6 ft. deep, and at the spring they are increased to 9 ft. The base of the arch extends several feet on either side beyond the street lines, so that there is 6 ft., 9 ins. of head room over the outer edges of sidewalks. The extreme width of the arch will be 70 ft., leaving 60 ft. inside the parapet walls for 5 tracks.

Such large and costly structures must become more and more common in all our principal cities; but in erecting them we should remember that they are to stand as monuments for very many years, and take all care that they do not violate the canons of good taste.

The Price of Gas in England.

An article in *The Engineer* on the price of gas gives some details of English practice which may be abstracted as follows: The cost of gas is in a great measure dependent upon what can be realized from the sale of the residual products. The price paid by the consumer is not a direct index of the cost, as the amount of capital and the terms on which it is raised come into the account and influence the price. Leaving out the item of interest, the cost of delivering gas in London is, with two of the leading companies, 45 cts. and 36 cts. per 1,000 ft. A difference in the quality of the gas in part accounts for this difference in cost. In the case of the second company, an allowance of 3½ per cent. interest on the capital invested would only increase the cost to 44 cts. per 1,000 ft. The cost of manufacturing gas at Government works is cited, in an instance where the capital invested is $80,000, and the production 157,135,000 cu. ft. annually, at 48 cts. per 1,000 ft., which includes all interest and salary charges.

The selling price of gas in London varies from 58 cts. to 66 cts. per 1000 ft., depending on the quality. In localities where coal is very cheap, as at Newcastle, the selling price is reduced to less than 50 cts. At Plymouth a rather inferior gas is sold at 44 cts. per 1000 ft., and at Leeds a gas of standard quality is sold for the same price, but the Leeds company shows a loss of $15,000 on the year's operations. In small communities in England and in many places in Ireland and Scotland the price is much higher, in some instances being $1.50 per 1000 ft. In Scotland, however, the gas is of superior quality. The capital invested in the manufacture and supply of gas in the United Kingdom is about $270,000,000, and the annual production exceeds 54,000,000,000 cu. ft.

ENGINEERING NEWS.

THE Keely Motor again comes to the surface. An "exhibition" to be made before the Court and experts has been postponed 60 days, to give time to clean off the rust and erect the dismantled machinery. At the exhibition, which will take place early in July, the Keely Motor Co. will be represented by counsel and an expert.

A REMARKABLE piece of railroad has just been completed in the Aptos gulch, California. Four years ago the Loma Prieta Lumber Company built 5 miles of road, and last June they employed Engineer MCLEOD to extend the line 2 miles into the mountains. Unusual difficulties attended the construction of this line, but they were finally overcome. The average grade of the new extension is 211 ft. to the mile, the maximum grade being 264 ft. The maximum curvature is 24°. When the basin is reached through which the road runs for a mile there are lighter grades and harder curves, there being one 26° curve, making a total angle of 97° The grades of 211 ft. are on the 24° curves, the grades of 264 ft. being on the tangents. The road crosses and recrosses the creek many times, requiring numerous trestles and bridges. On one of these bridges there is a curvature of 80° on a 50-ft. span. At the high bridge, the track is 75 ft. above the bed of the creek, and a quarter of a mile above it is "Devil's Gate," a narrow gorge occupied wholly by the creek, where the road is cut through the rock, and is only 7 ft. above the creek. This gorge was a difficult passage, 2 bridges being required in a space of 150 ft. A special locomotive is used on this line.

As we go to press, news reaches us of serious fires from natural gas at Buffalo, N. Y. The trouble seems to have been an increase of pressure in the mains sufficient to burst open the meters and allow the gas to escape. Of course wherever the escaping gas happened to be ignited its volume was sufficient to make a pretty large blaze. Fortunately the trouble ocurred at about 9 A. M., a time when few lights were about, and in only a very few cases was the gas ignited. Had the increase of pressure occurred in the evening or during the night, the damage and fatality would have been many fold greater.

The accident will doubtless greatly hurt natural gas in the public estimation, though the only reason why it is one whit more dangerous than ordinary gas is its liability to an increase of pressure on the mains, if for any cause the safety valves which relieve the pressure fail to act. This should be rendered as nearly impossible as human care can make it, and in the present state of mechanical knowledge there is no reason why these safeguards should not be made practically perfect. Perhaps it would be well to make the meters strong enough to withstand some increase of pressure, but this is only a minor point. It should be understood that all the difference between entire safety and terrible danger lies in the perfection of the apparatus for relieving over-pressure; and enough different methods should be provided for effecting this so that the possible failure of one or two will still leave others to act in their place.

A SYNDICATE consisting largely of Canadian Pacific capitalists, headed by J. C. ABBOTT, member of the Dominion Ministry, has been formed to undertake railway works in Brazil. Two surveyors have already started for Brazil to make preliminary surveys and report on a series of railways connecting the inland waters of the Amazon and Para rivers.

THE *Atlanta Constitution* repeats a good story of railroad location told by the Hon. W. B. BERRY:

"When the Atlanta & West Point Railroad was being built, party strife was at its height. Those in charge of the location of that part of the line which ran through Coweta were of the unterrified, uncompromising Whig stripe that fought for Whiggery by day and dreamed of it by night. They decided that the road should be a Whig road, and that it should not be defiled by running through the lands of any Democrat. So they surveyed a route, making a bend here and a turn there and when the work was done it was found that from Palmetto to Newman—a distance of 14 miles—they had run through the land of but one Democrat. And so the road runs to this day."

Without expressing an opinion upon this peculiar case, it is safe to say that a ride over some of the roads in this country is convincing proof that something aside from a desire to select the best line has influenced their location.

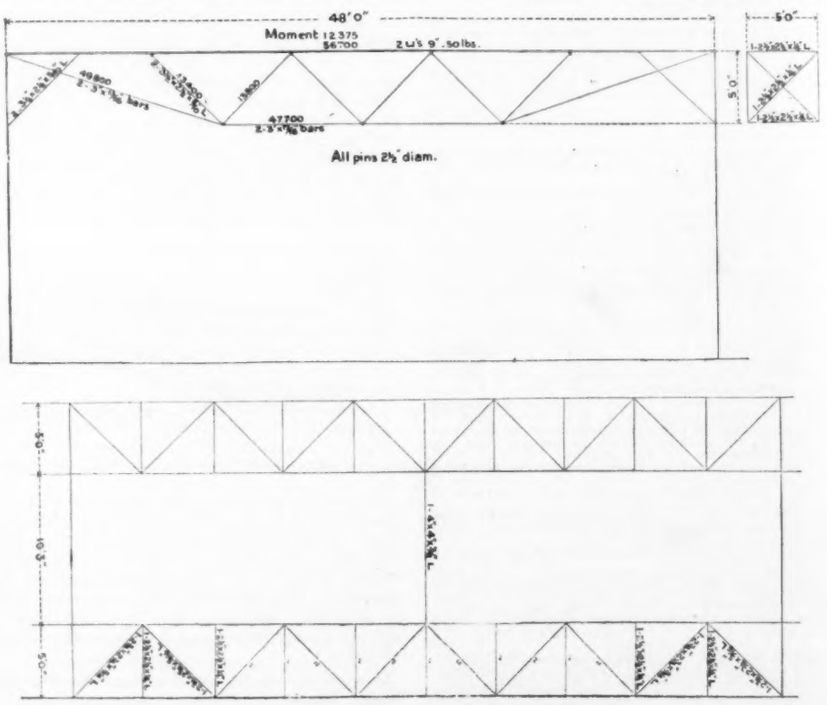
HAWKSLEY'S patent staircase is used extensively for public buildings, etc., in England and Germany. A cast-iron frame holds the steps, which resemble grates, the division irons being 1¼ ins. deep and ⅛ in. thick, with a clear space between 1¼ ins. sq. Pieces of oak 1½ ins. long are driven firmly into these spaces, and are left projecting ⅛ in above the surface of the step. When the joints are filled up a very safe step is obtained, and as the pieces of wood can be replaced, the cost of maintenance is slight.

A DECISION has been rendered in the Supreme Court of Minnesota in the case of the Railroad Commissioners against the Chicago, Milwaukee & St. Paul Railroad, in favor of the Commissioners, the road being forced to reduce its rates on milk as demanded by the Commission. The point involved was the right of the State to regulate railroad rates.

POWER is being conveyed in a very convenient way through bore-holes at the Shenandoah mines, Pennsylvania. An 8-in. hole lined with 5⅝-in. casing pipe extends from the surface to the seam, a distance of 244 ft. Through this passes a 1-in. steel wire rope for transmitting the hauling power required below. Another hole, 6-in. in diameter and 118 ft. deep has two 2-in. pipes, one of which is used for a speaking tube and the other for a bell-wire.

Inter-State Rapid Transit Railway.

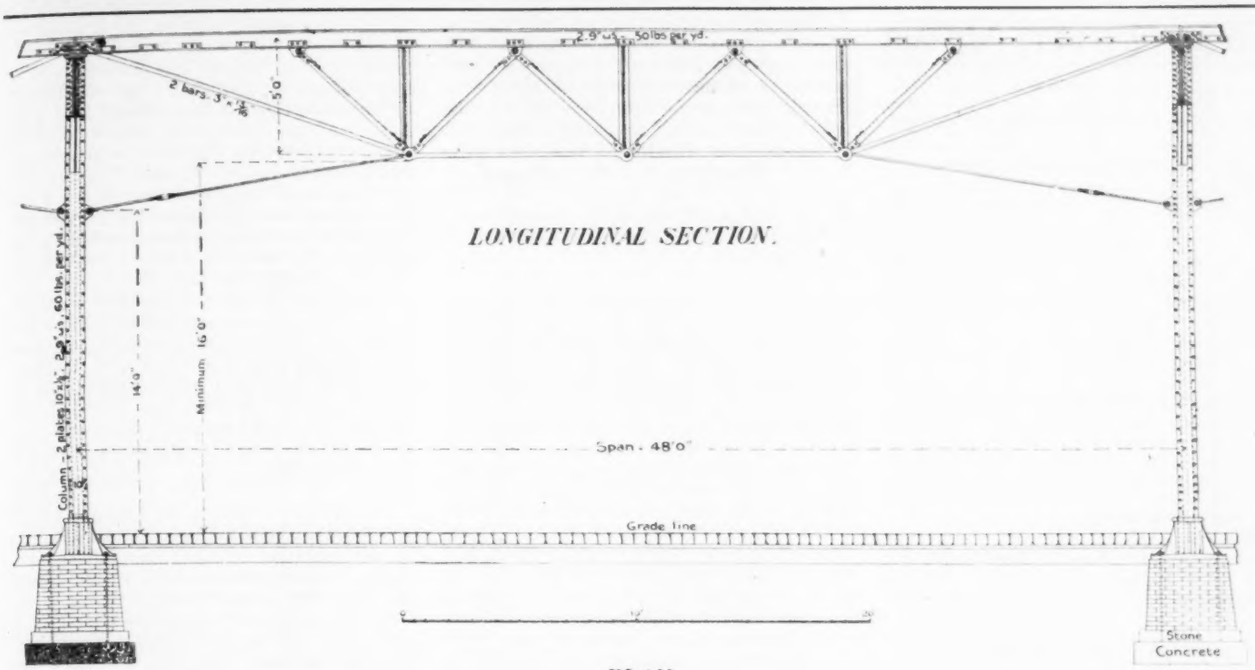
We continue from the issue of April 28 our illustrations of the Kansas City elevated railway structure, giving general views of the truss with supporting columns and the strain diagrams. The main requirements of the specifications for the steel superstructure, were as follows:



Inter-State Rapid Transit Railway; Strain Diagrams.

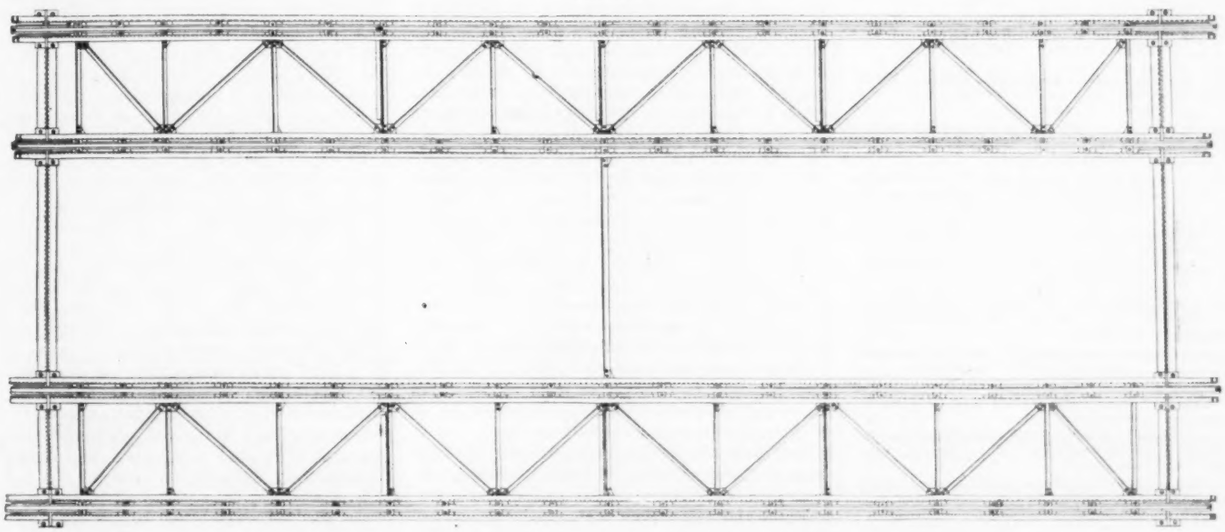
LOADS.

Rolling load on each track as shown on diagram. Length of motor 15 ft. over all; wheel base, 4 ft. cars 32 ft long over all.



LONGITUDINAL SECTION.

PLAN.



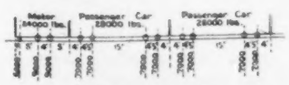


Diagram of Loads.

Wind Strains.—Thirty pounds per sq. ft. at street crossings. Twenty-five lbs. per sq. ft. between streets. Pressure of wind estimated on exposed surface of both trusses, and on moving train 10 ft. high covering truss.

WORKING STRESSES.

Wind Members: Twelve thousand five hundred (12500) lbs. per sq. in. in compression, and fifteen thousand (15,000) lbs. per sq. in. in tension:

Main Structure: Ten thousand (10,000) lbs. per sq. in. tension. Strains in compressive members per sq. in. determined by formulæ as follows:

Two pin bearings $\frac{8000}{1+\frac{L^2}{18000\ r^2}}$

One pin bearing and one square bearing $\frac{8000}{1+\frac{L^2}{24000\ r^2}}$

Two square bearings $\frac{8000}{1+\frac{L^2}{36000\ r^2}}$

Inter-State Rapid Transit Railway.
ROBERT GILLHAM, *Engineer.*

When length is not over twelve (12) ft. diameter strain per square inch, eight thousand (8000) lbs.

Impact.—Members subject to impact shall be proportioned by adding to area provided as above, for dead and live loads, as follows:

Middle ties and posts, 10 per cent. Counters, floor beams and stringers, 25 per cent. Riveted floor beams and stringer connections, 50 per cent. Floor beam hangers, 100 per cent. Vertical rods supporting floor beams directly, 25 per cent. Spans under 30 ft., 15 per cent. Spans under 50 and over 30 ft., 10 per cent.

CAMBER.

One twelve-hundredth of span. One-half of camber being taken out of track stringers.

STEEL TESTS.

Full sized pieces shall show an ultimate tensile strength of 60,000 lbs. to 68,000 lbs. per sq. in. Elastic limit, 32,000 lbs. Elongation 12 per cent. in lengths of 12 ft. Reduction of area before fracture 30 per cent.

In addition to the above a further and slightly higher test was specified for sample pieces of one half square inch in area of cross section to be cut from full sized pieces and annealed. Also a requirement that a test piece heated cherry red and plunged in water at 82° Fahr. should bend 180° with interior curve of twice the smallest diameter of the sample, without cracking.

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Coming Technical Meetings.

American Institute of Mining Engineers.—The 81st meeting will be held at Birmingham, Ala., May 15. Secy. R. W. Raymond, 13 Burling Slip, New York City.

Engineers' Society of Western Pennsylvania, Pittsburg, Pa.—Regular meeting, May 15. Secy., S. M. Wickersham, Penn Building.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, May 16. "Small Pipe Sewers." Secy., S. E. Tinkham, City Hall.

American Society of Civil Engineers, New York.—Regular meeting, May 16. "High Masonry Dams," Jas B. Francis. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of St. Louis, Mo.—Regular meeting, May 16. "Water Way between the Lakes and the Mississippi," R. E. McMath. Secy., W. H. Bryan, 709 Market St.

New York Railroad Club.—Monthly meeting, May 17. "Automatic Drawbars for Freight Cars." 113 Liberty St.

Engineers' Club of Philadelphia, Pa.—Regular meeting, May 19. Secy., Howard Murphy, 1122 Girard St.

Missouri Association of Surveyors and Civil Engineers.—Annual Meeting at Columbia, Mo., beginning May 31. Secy., T. J. Lowry, Columbia.

Engineers' Club of Kansas City, Mo.—Regular meeting, June 4. Secy., Kenneth Allen, 19 Deardorff Building.

Master Car Builders' Association.—Next convention at Alexandria Bay, N. Y; commencing June 12. Secy., M. N. Forney, 46 Broadway, New York City.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy. Angus Sinclair, Chicago.

Ohio Institute of Mining Engineers.—Summer meeting at Logan, O., July 11, 12, 13. Pres., W. H. Jennings, Columbus; Secy. R. S. Weitzel, Kittanning.

THE papers have been full this week of charges and counter-charges in regard to the new aqueduct work. It appears to be clear that politics had considerable to do with the letting of the contracts, and even the ermine —or whatever other fur he wears—of the Governor is distinctly smirched. Two other facts, however, which seem to impress the public as highly improper will have no such effect with engineers. The first is that some of the work was "sub-contracted" in defiance of a prohibition of the main contract, and the second is the alleged fact that the sub-contract was let so as to leave a profit of 11 per cent. "without touching the work." It is also alleged, and seems to be clear, that "the lowest bidder" was not always sure of the work, and it appears to be admitted on both sides that some of the work is not properly done, and needs to be done over to pass, the dispute being as to the amount. The extraordinary spectacle of an independent engineering examination by an engineer (EUGENE E. MCLEAN) acting on behalf of and under appointment by Controller MYERS, regardless of the regular engineering staff of the work is also presented to a wondering world, although it would seem evident that without either impeachment or removal of the duly appointed Chief Engineer and staff, his estimates and reports would have to govern under the contract in accordance with its explicit terms. Other absurd claims are, that whatever is wrong about the distribution of the contracts is due to the addition of three other members to the original board of six, in place of the Mayor and other *ex-officio* Commissioners, and hence that all troubles can be cured by removing them.

Fortunately it is needless for us to even attempt to go to the bottom of the facts and draw positive conclusions, which would be an extremely difficult thing to do. But one general fact is quite clear: However much or little money may have been improperly made by individuals out of the aqueduct contracts the work as a whole has been prosecuted with the most extraordinary vigor and success, and at a cost to the city which is certainly not excessive, being far below what the work could possibly have been executed for a few years since. The work has gone on from first to last smoothly and without a hitch, and few contractors could have been expected to prosecute it throughout with equal smoothness and success. Hence, if any contracts have been awarded to those who have done the work in spite of lower bids, the wisdom of so doing is to a large degree justified by the result, and it is no more than is constantly done in letting large railway contracts, which are now rarely awarded to the lowest bidder by large companies, responsibility and practical skill being far more considered. Similarly, sub-contracting of the kind which appears to have existed on the aqueduct, paying the chief subordinates by an interest in their particular work instead of by fixed salary, is in no sense an injury to the city, nor a violation of the spirit or true intent of the contract, whatever it may be as to its letter. Something of the kind is almost an essential for the smooth conduct of so great a work, and that there should be any row made over an agreement of the kind by which the main contractors made 11 per cent. "without touching the work" is simply absurd. Every large contractor expects to clear as much as that on sub-contracts, and must do so to be sure of keeping himself whole.

The talk of the engineering staff having been too large seems to us equally absurd. It ought to be large to ensure quick and good work at the same time. The only improper thing, if impropriety there be, is that with such a staff there should be any considerable amount of bad work left behind to be discovered in the eleventh hour—when a large part of it cannot be discovered. Should it be proved that there is any considerable amount of such work, that would be a damaging fact; but it would be well for the press and public to reserve its indignation until this, or the political interests in the contracts, have been proved, and not dilate upon "sub-contracts" and "lowest bidders".

THE latest statements as to the aqueduct work point to BROWN, HOWARD & Co. as the wicked partner. According to the report of Chief Engineer CHURCH there has been more or less trouble with their work since last October. In spite of the fact that much of their work was condemned and torn down from time to time because of defective rubble masonry, of some 550 holes cut through the brick and rubble masonry, early in March, about 80 per cent. are stated to have shown bad work, which is certainly an enormous proportion. The sum withheld from this firm on their contracts is $1,041,614.14, which, in the opinion of the Chief Engineer, is ample to protect the City against all loss, but it is almost impossible to ever make sure that work in which so many defects are discovered is all right without rebuilding it. An examination of the whole line has been started, and some holes cut; but, outside of BROWN, HOWARD & Co.'s contract, no bad work of importance has been discovered. It seems unfortunate and somewhat surprising that so much bad work should exist on one section, but the difficulty of preventing it is sometimes very great, and that the work as a whole has been so quickly, cheaply and well done as to be a credit to New York and to American engineering, we take to be beyond doubt. O'BRIEN and CLARK may be very wicked men, but they have incontestably proved themselves to be excellent contractors, and their wickedness in letting part of their work in a practical sub-contract, which cleared them 11 per cent., is a rather absurd thing to dwell on at length in the newspapers.

THE farce of "ordering off" the great C. B. & Q. strike, which had been almost forgotten in the meantime by every one but the sufferers, was duly gone through with last week, and it is now even in name a thing of the past. The men were completely worsted at every point, and it is well that it should have been so, not that they may not have had some just causes of complaint, had they appealed for a settlement in a different way, but because it is a necessary condition of peaceful modern life that "those who take the sword shall perish by the sword" when they appeal to it unnecessarily, without first exhausting every chance of agreement by peaceful negotiation.

Since the publication of our article of March 24 discussing this question, we have received from one of the officers of the C. B. & Q. statements tending to show that the men really had little or nothing to complain of, but were paid fully as much as on other roads. We have not published this matter, however, for the reason that, as we then said, whether they had or not originally is really nothing to the purpose. Their wrongs, if any, were of a kind easily susceptible of negotiation, and which were certain to be redressed by negotiation only, if pushed far enough, to the extent that they were real. Wrongly assuming that they had the power to command success they deliberately waived the question of whether they deserved it, and it is in every way fortunate that this relapse of an excellent organization into bad methods was defeated. What we wanted to especially point out, however, was that the strike was much more decently conducted than any other one of equal magnitude, and that there is a distinct tendency to this effect in the labor organizations generally which is very encouraging, combined as it is with a more conciliatory attitude on the part of employers. We are unable to see in late events any evidence that the "labor question" is becoming an increasingly threatening one, but rather that it is becoming distinctly less so.

THE people who are doing what they can to oppress and injure our American railway properties are very active now-a-days. The Texas State Courts have sustained Attorney-General HOGG in his attack on the Texas Traffic Association, but the case has, of course, been appealed to higher courts. In Nebraska the charter of the Atchison & Nebraska, a leased line of the Chicago, Burlington & Quincy system, has been annulled under the provision of the State Constitution forbidding the consolidation of competing lines, a provision which is a disgrace to the constitution of any State. The Minnesota State Business Men's

Association has made a complaint to the State Railroad Commission, alleging that the St. Paul, the Northwestern and the Omaha discriminate against most of the cities and towns in the State. The Produce Exchange of New York City is out with a severe arraignments, showing how the railroad and steamship companies are carrying grain from Chicago to European ports at rates actually less than those charged from Chicago to New York. One item of encouragement comes from Florida, however, where the State Railroad Commission has revised its schedule of maximum passenger rates, raising the limit to 4 and 4½ cts. per mile.

WE regret to find that we are furnishing ammunition to our esteemed contemporary *The Engineer* for renewed attacks on America and American ways. It has discovered that we publish a weekly summary of all reported bridge and trestle accidents, and has taken to inserting almost weekly paragraphs like the following:

"Bridge accidents are as common on the American lines as trains. The following bridge accidents are reported by the *Engineering News* in one week:—On Feb. 26 the upper Bum river trestle, near Anoka, Minn., gave way under a team, etc. On Feb. 28, the abutment of the Beaver Creek trestle, near Reynolds, Ga., gave way, etc. On March 1st, a Southern Pacific stock train went through a span of the Hondo Creek bridge, etc."

We trust our contemporary will find this kind of amusement as profitable as it is easily indulged in. It is at once less trouble and more gratifying to national pride to cut such records out of foreign journals which take the trouble to collect them, than to hunt up the records of bad practice in one's own country, but whether it is in the end as beneficial to the best interests of that country we take the liberty of doubting. Not only in engineering but in political and other matters it is a notable difference between the American and English press that the first is perpetually pointing out and protesting against every evil it discovers at home, and paying little attention to the faults of other countries, while the last too often parades with foolish glee every fact about other countries which tends to gratify national self-conceit, while it may be hunted through in vain for any allusion to defects at home.

Which shows the healthier condition?

We shall not undertake to say, but we shall continue to furnish *The Engineer* all the ammunition of the kind which we can discover, on the principle of the whist maxim that it is more important to inform one's partner than to deceive one's antagonist. If *The Engineer* likes the game of bumblepuppy better, it is welcome to play it. With 150,000 miles of railway in the one country, mostly new and through new country, and only 19,000 in the other, mostly 20 or 30 years old and built at four to eight times the cost, an excess of ammunition should naturally come from this country under any circumstances, but we have not the least objection to have it continue to all come from here, as we fear it will if it is left to the enterprise and public spirit of *The Engineer* to collect it on the other side.

Mr. FRANCIS E. GALLOUPE, M. E., of 30 Kilby St., Boston, Mass., whose numerous and excellent contributions to this journal will be remembered, has recently compiled a most admirable index to the leading engineering periodicals for the past five years (1883 to 1887 inclusive) for which he is desirous of securing enough subscribers to warrant the expense of publication. From personal examination we can certify that the indexing has been most admirably and carefully done, and we desire to urge it as a duty on every engineer that he should at once forward his subscription to the work, which is announced at the very reasonable price of $2 per copy.

As every one concerned has had occasion to find out, the engineering arts advance so fast that it is difficult, if not impossible to keep technical books up to them. Almost as soon as they are written they are old. For the latest information as to the latest practice recourse must be had to the scientific periodicals, and it is a thousand pities that some one or more of our engineering societies cannot be persuaded to undertake the indexing of such matter as a permanent feature of their technical work, which would certainly be one of the most useful features. But as this cannot be, or at least is not done, and as an individual has undertaken and successfully performed this great labor for five years at least, every engineer should aid its publication by subscribing for it, first as a duty to himself, since he may need the book badly and not be able to get it; secondly, as a duty to Mr. GALLOUPE, who has performed a great and useful labor for which there can be little if any direct return in money, and thirdly, as a duty to the profession, to the literature of which the index will be an addition of permanent value which must be encouraged to appear at all. Mr. GALLOUPE thus describes the publication:

It is proposed to publish at once an Index of Engineering articles contained in leading periodicals during the last five years (1883-7 inclusive), should sufficient subscriptions to the book be received. The periodicals included in Index are *Engineering News*; *Iron Age*; *Mechanics*; *American Engineer*; *Sanitary Engineer*; *Eng. and Building Record*; *Railroad Gazette*; *Van Nostrand's*; *Railroad and Eng. Journal*; *Journal of Franklin Institute*; *Street Railway Gazette*; *Electrician*; *Electrical Review*; *Electrical World*; *Scientific American Sup.*; *The Locomotive*; *Society of Arts Proceedings*: *Engineering* (London); *The Engineer* (London).

The work, which is now ready for the press, contains upwards of 10,000 carefully selected references, arranged in a single alphabetical index by subjects, covering information now only to be extracted by the aid of some 150 different indices, and is designed to make accessible to engineers in all branches of the profession, to special investigators, librarians, editors and others, such information without loss of time. It will be an octavo of about 250 pages, 5⅛ × 8 ins. cloth bound and sold at $2 per copy.

How to Begin in Engineering.

Every few days we receive inquiries resembling very closely the following, which we have just received from a correspondent:

"I am a young man, recently graduated from the State Military Academy of South Carolina, and wish to enter the profession of engineering, and I should be glad to have your suggestion as to what branch to engage in. I wish to enter work immediately."

It is impossible to answer such queries definitely of course, for all depends upon the man and his opportunities, and yet we usually attempt to do so by personal letters, realizing that a brief word of advice is often a great help to young men. There are so many just at this season, however, who are asking this question of themselves and others, and we may add, such a perennial crop of others who are asking themselves how to begin over again, after a more or less false start, that perhaps we can best answer this correspondent and others at the same time in our own columns.

The one condition of permanent success in engineering, or any other calling, is to know how to do some one thing that needs to be done thoroughly well, and the one condition of great success is to know how to do it better than any one else, or than almost any one. Engineering, like every other profession or business of an attractive nature, is filled to overflowing in its lower ranks with lazy, mediocre or half-informed men, and this must always be so, because almost every man seeks to engage in some calling a little higher than he is naturally qualified for, and having once made a start in it, clings desperately to every chance of advancement, so long as he has a chance. Engineering is especially afflicted in this way because there are more "ups and downs" in it than in most other professions. The demand for doctors, lawyers and ministers, is relatively constant. Even architects are not subject to great fluctuations. But to give any man employment as a civil engineer, some one must be spending a good deal of money, most of which is in the form of permanent investments, although a good deal of it (luckily) is in the form of maintenance, which must go on in good times or bad. Such investments are apt to be large for several consecutive years and then fall to almost nothing. During the "boom" years almost any human being who will call himself an engineer can get employment of some kind, and accordingly many are drawn in who would hardly get in otherwise at all. When the reaction comes, and there are not half enough positions to go around, the struggle to get what there are is fierce, and it is not always the best man who wins, by any means. This is especially so because most engineers are professional vagabonds, here to-day and there to-morrow, as engagements offer, so that their past work, however good, is often of little help to them, and because their knowledge of possible engagements is limited to their immediate surroundings, whereas it ought to be continental if they were to have as fair a chance relatively as the doctor or lawyer or architect, who plants himself in one place with the expectation of staying there permanently, and with the knowledge that as many engagements are to be had there as anywhere if he establish his fitness for them.

Again, engineering tends to become overcrowded from the fact that there is more room in it for young and immature men than in almost any other profession, with the consequent result that such men are better paid. There is no demand for assistant doctors or assistant ministers with most of their training yet to gain, and very little for assistant lawyers, but every large engineering work has dozens of young assistant engineers necessarily employed on it, although it has only one chief. Accordingly, it is very easy for young men to work up to salaries of $1,200 to $1,800 a year in good times, with moderate industry and ability, and enjoyment of such income is no sign at all that their possessor will permanently succeed in the profession, whereas the young doctor who earns $1,200 a year from his practice has his future success assured, because it takes him years of hard work and poor pay to reach that point. Engineering is something of a mouse-trap, therefore. It tempts the young man by an unusually easy road to good pay for a young man, but when he has got that much it is apt to drop him very suddenly and very hard, on the briefest notice, and it is sure to oppose much more serious obstacles to his future advancement. Moreover, because of this very ease in entering the profession, the higher walks are overcrowded, and pay in them rules far lower in proportion than it should. Many a young fellow of almost no experience gets $1,200 to $1,800, when his Chief, who has had years of experience and far heavier expenses, is thankful to get $4,000 to $5,000 while he can, and then scratch around for an other plum of the same kind when that is eaten up.

There are likewise, of course, many permanent positions, but even then they are far from permanent in the sense that a doctor's

or architect's practice is permanent; *i.e.*, his own personal creation, whose perpetuity depends on himself alone. The engineer is at best dependent on the pleasure of corporate officers, and is at the worst dependent on the fluctuations of politics and the whims of politicians;—the last constituting a large and unfortunate class, who early learn that a small political "pull" availeth more than much knowledge, and who are accordingly driven into manipulations of that kind to keep their place, which to many of them are most distasteful. If there be one piece of advice to young men, therefore, which is certainly sound, it is to keep out of all branches of political engineering so long as he can, unless he is conscious of having those peculiar wire-pulling faculties which are so necessary in most such positions, however good an engineer a man may be. This we say despite the fact that some of the most important and interesting engineering works come under this head, and many of the ablest men in the profession have to do with them.

So far we have spoken only of the "blue" side of the profession, which is the side that most men are disposed to look on in whatever profession they may have engaged, because the road to success in all is hard; but on the other hand, there is probably no one profession offering to the young man so many "chances" as engineering. Few or no engineers get rich in the strict line of their profession; but as the training is of a practical nature it is the best possible preparation for many kinds of business life, as notably for contracting, as well as for executive positions in the management of railways and other large enterprises. Thus the balance is kept true, and on the whole, we believe, there is no more desirable profession than engineering for a young man to enter, for the reason that it leads him directly to more diverse opportunities than any other, from which chances a choice may be made as his experience directs.

But if there be anything clear from this brief summary of the nature of the conditions which a young man has before him, it is that he has especial need to lay the foundations of his professional knowledge broad and deep, and that he should early choose some one branch, and of this he should make a point of mastering all there is to know. Does he wish to live merely for to-day? Let him seek for some place at $60 or $75 a month, jump at once for the next place which will pay him $10 more, and so keep on as long as he can, taking no trouble to do or know more than is immediately necessary for his daily work. He will soon find himself at the end of his rope, and doomed to be a hack for all his life unless he develops more talent for business than he does for his profession, as many do; and if a man suspects himself of little competency for mastering the *professional* side of engineering, but desires only a good preliminary training for contracting or other business, and an opportunity to keep his eye out for such chances, he may do well enough to take just this course. But the man who would really succeed *as an engineer*, and not find his future life needlessly up-hill work, should start out with the fixed idea that his first six or eight or ten years are chiefly useful to him to lay the foundations for future success and to earn a livelihood in the meantime. Therefore, if he has graduated from such a school as our correspondent mentions, where strictly professional studies are not carried very far, his chance for ultimate success will be greatly enhanced by his seeking some position on an engineer corps where he can earn some money and gain experience as well for a year or two or three, and then bending all his energies toward obtaining at least two years' further training in some good engineering school. Such a course after a year or two of practical experience is always more profitable to a man who is in earnest than if his school life be continuous; and if he then seeks first engagements which will give him a good experience and some prospect of permanency rather than high pay, and devotes his next three or four years largely to advanced study of what is likely to be his chosen branch—and he will find it no burden to do so if he has not mistaken his calling—he will find himself ere long in a position from which his advancement will be rapid. Advancement in all professions follows somewhat the law of the parabola; departing from the zero line slowly at first—often with discouraging slowness—but afterwards far more rapidly. But the one course which is sure to ruin a young man's chances in this, as in all other professions, is to be content with a mere smattering of knowledge, to lay up none in advance against the day when it is needed, and to conclude that it is "cheek" and "luck" rather than solid hard work, which will carry him ahead. Such belief in "luck" is the most deadly enemy of every young man's future. "Luck" surrounds every man for all his life, and as respects getting hold of any one particular chance, we may admit that it is all luck, just as it is "luck" whether one meets any particular person on the street. But the people are always there; and whether one will have the chance to button-hole many desirable units among them or not, depends chiefly on the pains he has taken to qualify himself to do so beforehand. If he has taken such pains in professional matters it may still be "luck" whether his chances come to-day, to-morrow or next week, and even whether he gets the very best plums to be had or only average plums, but in the main, a man's success or non-success depends strictly on himself. If he fail in spite of qualities which should give him success, he can generally find the reason within himself by looking for it, perhaps merely in some collateral trait or obnoxious personal habit, having no real relation to professional qualifications, but having a great influence on success. It may even be an honorable trait which ought not to be corrected, which temporarily stands in a man's way; but whatever be the reason, there is always a reason of some kind within the man for persistent lack of fair success, and no hope for a change of "luck" until he recognizes and corrects it.

In what particular branch of engineering a man makes his first start, if he has worked in the spirit outlined above, matters comparatively little. No one branch can long continue to offer much better chances than another, or all men would flock to it and overcrowd it. In all, there is "room at the top", with two exceptions, which are hence the least desirable for any young man to enter: the first is the government service in river and harbor work, as at present organized, where there is absolutely no chance to rise beyond a certain low grade, while yet the experience is of relatively little value for other work, almost tending to unfit a man for it: and the second is the political field before referred to, although it has in some of its corners great prizes and contains much valuable experience. The railway field is a great one, and offers many prizes, although with certain disadvantages. In entering it, or in remaining in it, the young man should by all means bend all his energies to a comprehension of the theory and practice of locomotive and car construction, and to the routine of operating practice as well as construction or track work. The fields of mechanical and electrical engineering are becoming increasingly attractive, and sound technical knowledge increasingly essential for success in them. But to whatever branch a young man feels attracted or may chance to find an opening in, he cannot go amiss in doing all he can to master it, which he may do with tolerably safe assurance, that what he thus does will be useful to him in the end, even if he ultimately changes his aim somewhat.

The "conclusion of the whole matter" is:—it is hard work which tells; to what particular branch that work is directed matters relatively very little.

The Past and Future of New York.

III.

THE FUTURE OF NEW YORK.

In Table X. we abstract from preceding Tables the percentages of growth for the three main divisions of New York metropolis, the New Jersey, Long Island, and Manhattan Island and Westchester Co. together, and also for the whole metropolis. Adjacent to this are given the similar percentages for Philadelphia, Boston proper and Boston with its suburbs, and for London. As will be seen by referring back to Table II., Westchester Co. has so far played but a small part in the development of the metropolis, and that a part of decreasing importance.

Judging only from this table, which ends at 1880, it would be a natural conclusion that the very rapid growth of cities might be coming to an end. As we saw last week, however, this temporary check is chiefly a result of inferior transit facilities, of the depression due to the war, and in some degree to the prolonged depression in business from 1873 to 1878. The data given in Table IV. of our issue of April 28 makes it absolutely certain that New York will show a far heavier percentage of increase in the decade 1880-90 than in the preceding decade, because it had already exceeded that decade in 1887, so far as erection of new dwellings was concerned. On the other hand, the average population per house will probably show a considerable decrease during this decade as a result of the elevated railways, so that the erection of new buildings is not a certain guide, and its apparent indication, before noted, of an increase of population of 34.37 per cent. on Manhattan Island, giving 1,564,959 in 1890, is probably excessive.

TABLE X.

DECENNIAL PERCENTAGES OF GROWTH OF PHILADELPHIA, BOSTON AND LONDON IN COMPARISON WITH THE VARIOUS SECTIONS OF THE NEW YORK METROPOLIS.

	N Y etc	J.Cty etc.	Br'k-lyn. etc.	Tot'l N. Y.	Phila	Boston,		London.
						Pro-per.	3 Cos.	
1870-80	22.5	37.8	39.9	29.7	25.7	44.0	25.1	17.2
1860-70	17.6	63.0	46.7	31.4	19.2	40.5	23.1	16.4
1850-60	59.1	80.5	91.5	68.8	38.3	33.4	37.2	18.7
1840-50	58.8	58.2	125.5	68.0	58.4	50.9	49.7	26.2
1830-40	50.9	30.7	82.0	51.1	36.7	54.1	33.7	23.5
1820-30	53.3	31.4	30.9	44.8	39.2	41.6	24.4	23.5
Av	42.6	49.2	66.2	48.2	35.7	43.9	31.9	21.5
1810-20	23.4	15.0	18.3	20.8	22.0	27.7	19.2	19.2
1800-10	44.1	11.4	22.1	31.9	73.2	22.7	15.9	19.2
1790-1800	53.9	25.8	10.4	36.4	63.3	—	16.6	sma'l

The geographical subdivisions by counties noted under Tables I. and V.

But the causes tending to the further great and almost unlimited development of cities are so evident as to make it certain that the substance of these figures is not deceptive. While it is not likely that the next four or five decades will show anything like the average rate of the past six decades since 1820, and

perhaps never again such enormous jumps as were produced 30 or 40 years ago, all over the world, by the general introduction of railways, yet it is apparent that the check upon the growth of cities from bad internal transit facilities is about to be permanently removed by the progress of the arts and sciences, as it already has been to a large extent within the last decade. It is unmistakeably clear that elevated and under-ground roads are to greatly multiply in the remaining years of the nineteenth century, and, what is a still more important matter for New York, that the building of great bridges across the North and East Rivers becomes every day a less serious problem, financially and technically. Hence the cost and comfort of living in great cities is sure to become more favorable to their growth. The growth of wealth and of manufactures goes on meantime far faster than ever before, and the productiveness of one man's labor in agriculture is likewise steadily increasing.

All these causes combine to stimulate the further growth of cities. Therefore, bearing in mind that London has steadily grown at the rate of nearly 20 per cent. per decade up to 4,000,000, and that this rate has not tended to fall off appreciably with growth of population, is there the slightest reason to doubt that New York, as the metropolis of twice as large a population which is now advancing fully twice as fast in number and wealth, will at least maintain an average decennial increase of 30 per cent. for the next 40 or 50 years, as against 8.2 per cent. in the past 60 years? Rather, it is quite certain to be somewhat more, at least for the next 30 years, but let us see to what aggregates this practically certain minimum leads us, starting with the known figures for 1880. At 30 per cent. per decade increase we have in *thousands* of inhabitants.

1880	1890	1900	1910	1920	1930
2,588	3,358	4,366	5,676	7,378	9,592

In other words, by 1930, some 50 years ahead, the total population of the entire metropolitan area shown on the map given last week will be nearly 10,000,000. We cannot believe that this figure will be exceeded by that date but we do believe it will be closely approached, and that the figures given for 1890 and 1900 will be considerably exceeded. Space forbids our reproducing all the figures upon which this conclusion is based, but it is already practically certain that 1890 will show a larger aggregate, since the population is to-day very nearly that given.

The crucial question then arises; Where will these people be; and here we reach one of the most interesting features of our investigation. The ultimate capacity of Manhattan Island is far more nearly approached than is generally realized. To bring out the full facts clearly we have in Table XI computed the density of population of New York and parts of Brooklyn by wards, showing the figures thus obtained on the accompanying map, and Table XII we give corresponding figures for London and Paris. The amazing contrast is visible at a glance, and is one of the greatest interest. The terrible over-crowding of lower New York is absolutely without a parallel, and although the upper half of Manhattan Island had an insignificant population in 1880, yet taking the *whole* area and comparing with London and Paris, we have:

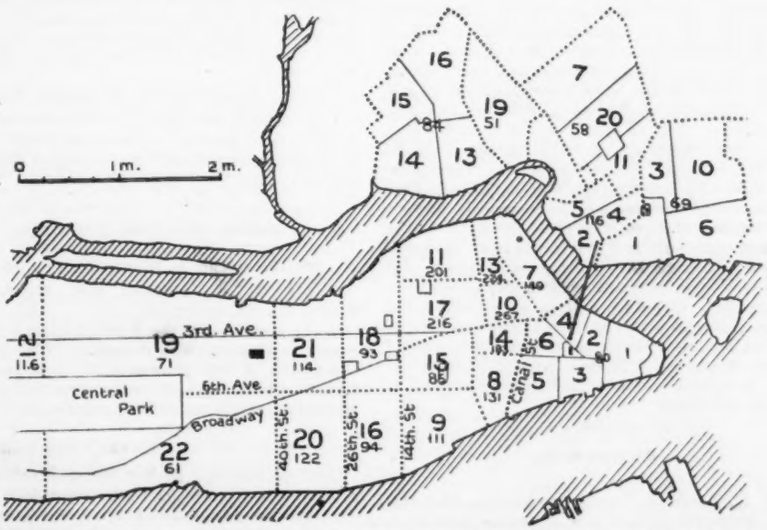
New York	on	17.6	sq. miles,	66,300 inh'ts per sq. m.
London	"	33.7	"	62,080 "
"	"	6.0	"	83,840 "
Paris	"	30.0	"	74,880 "
Low'r N. Y. only	"	8.8 ±	"	132,600 "

This, be it remembered, was in the bridgeless and rapid-transit-less era. That overcrowding resulting from such conditions is quite certain to decrease is indicated by the experience of London. Such conditions are soon to cease in New York as an effect of bridges and tunnels. Causes of a political and military nature have tended to overcrowd Paris; yet even in that city, and still more in London and Brooklyn, we have strong evidence that a population of 60,000 to 80,000 per sq. mile is the utmost which will result in any city when reasonable chance exists to expand into the surrounding country. New York is, hereafter, to have such chance and, moreover, its lower half is to be increasingly devoted to business. We are forced to the conclusion, therefore, that the population of Manhattan Island is likely to never greatly exceed 1,500,000, and that 1,833,000 exhausts the reasonable possibilities for its maximum population, after reaching which, it is far more likely to decrease than increase. This figure is obtained as follows:

Probable Maximum Population of Manhattan Island.

District.	Area. sq. m.	Pop'n. per sq. m.	Total.	Inc. or Dec.
Lower N. Y.,	1,003	50,000	50,000	D. 30,000
East Side,	2,053	150,000	308,000	D. 65,000
West Side,	3.282	107,000	362,000	000
40th to 86th St.,	4,077	100,000	408,000	I. 138,000
Harlem, etc.,	7,052	100,000	705,000	I. 623,000
	17,567	104,350	1,833,000	669,000

That the population of Manhattan Island will at any time exceed, or even attain these figures is in the highest degree improbable *unless* the impediments to rapid transit in the past are to continue in the future. This is not reasonably possible. The year 1900 will see true rapid transit to Westchester Co., one bridge at least across the North River, elevated lines all over Brooklyn, with cars running to New York direct, a very great enlargement of the capacity of the present Brooklyn bridge, and one or



DENSITY OF POPULATION IN THOUSANDS OF INHABITANTS PER SQUARE MILE OF THE MOST DENSELY POPULATED WARDS OF NEW YORK AND BROOKLYN.
(Wards 1 to 6 of New York and various wards of similar character in Brooklyn averaged together.)

TABLE XI.

AREA AND DENSITY OF POPULATION OF THE VARIOUS WARDS AND DISTRICTS OF NEW YORK CITY AND BROOKLYN.

NEW YORK.

Wa'd	Area sq. m.	Population. 1880	1870	In %	Pop. per sq. m. 1880	Location of Wards.
1 to 6	1.003	80,106	81 541	1.7	79,927	Below Canal
7	.336	50,066	44,818	11.7	149,010	
10	.178	47,554	41,431	14.8	267,160	Canal to 14th
11	.343	68,778	64,230	7.1	201,110	Street.
13	.169	37,797	33,364	13.3	223,650	East Side
14	.165	30,171	26,436	14.1	182,860	and Central.
15	.377	31,882	27,587	15.6	84,569	
17	.485	104,837	95,365	9.9	216 160	
Tot'l	2.053	371,085	333,231	11.4	180,920	
8	.273	35,879	34,913	2.8	131,430	Lower
9	.490	54,596	47,609	14.7	111,420	West Side,
16	.555	52,188	48,359	7 9	93,817	14th to 26th
18	.717	66,611	59,593	11.8	92,903	Streets.
20	.707	86,015	75,407	14.1	121,660	26th to 40th
21	.640	66 5:6	56,703	17.4	113,960	Streets.
Tot l	3.382	361,825	322,584	12.2	106,990	
19	2.240	158,191	86,090	83.8	70,620	40th to 86th
22	1.837	111,606	71,349	56.4	60,755	Streets.
Tot'l	4.077	269.797	157.439	71.4	66,175	
12	7.052	81,800	47,497	72.2	11,596	all above 86th St.
G'r'd Tot'l	17.567	1,164,673	942,292	23.6	66,300	Central p'k. etc., 1.334 sq. mls. excl'd

The area of Central Park and adjacent small parks is excluded. The entire area below 86th St., 10,514 sq. miles, averages 103,000 inhabitants per sq. mile.

BROOKLYN. MOST DENSELY POPULATED PARTS ONLY.

Ward.	area. sq. m.	Population. 1880.	1870.	In. p.c.	Pop. per sq. mile. 1880.
2, 4, 5	0.35	40,590	57,903	29.9	115,970
1, 3, 6, 10	1.44	99,577	79,348	25.5	69,151
7, 11, 20	1.34	77,531	62,734	23.6	57,860
19	0.54	27,661	16,321	69.5	51,225
13 to 16	1.35	112,954	84,204	34.1	83,668
Total.	5.02	358,313	300,510	19.2	71,377

PHILADELPHIA, in 1880, had a built-up area of 14 sq. miles, with about 60,000 inhabitants per sq. mile on that area.

TABLE XII.

AREA AND DENSITY OF POPULATION OF VARIOUS DISTRICTS OF LONDON AND PARIS.

LONDON.	Area, sq. mls	Population per sq. m 1801.	1841	1881
"City" within the walls.	.894	107,520	91,560	——
" " & witho't	1.044	122,880	118,400	48,640
" Westminster & Southwark	5.966	58,940	74,840	83,840
London within the old "Bills"	33.73	22,400	39,680	62,080
Limits of Richman, 1801. " Registrar-Gen. 1838 43	46.88	18,560	36,480	60,800
Limits of Registrar-Gen 1844-6	70.02	13,440	26,880	49,280
Limits within mortality tables 1851	87.98	10,880	21,760	41,600
	117.75	8,320	16,640	32,640
PRESENT MOST CROWDED DISTRICTS OTHER THAN ABOVE.				
St. Luke's, Chelsea	1.244	9,600	32,000	71,/40
St. Marylebone	2.353	26,880	58,240	65,920
Bromley	.950	1,920	6,400	67,840

PARIS, including a total area of 29.97 sq. miles, averages 74,880 inhabitants per square mile, the most crowded arrondissements being:

	Sq. Miles.	Inh'ts per Sq. Mile.
Bourse	.377	202,880
Temple	.448	209,920
Hotel de Ville	.605	171,520
Opéra	.822	149,760
St Laurent	1.105	144,620
Popencourt	1.394	150,400

The least crowded in this area are two arrondissements of about 2¾ sq. miles each, with 22,400 and 36,400 inhabitants per square mile respectively.

more new bridges or tunnels across the East River. Under these conditions the population of Manhattan Island is far more likely not to exceed 90,000 per sq. mile, or 1,481,000 aggregate (against 1,165,000 now) than the larger figure given. But assuming it to reach the larger figure, and that that growth will be attained by a nearly uniform growth of 16.3 per cent. up to 1910, with stationary population thereafter, we shall have for the population of Manhattan Island *in thousands*:

1880	1890	1900	1910	1920	1930
1,165	1,400	1,600	1,833	1,833	1,833

But the minimum probable population of the metropolis as a whole, we have found to be:

2,783	3,358	4,366	5,676	7,378	9,592

We therefore have left, as the population to be divided between New Jersey, Long Island, Staten Island and the Westchester Co. and "annexed" district, *in thousands*:

1,418	1,958	2,766	3,343	5,545	7,759

The first figure being the actual population of these as given in 1880, and the second not much above its aggregate to-day.

The limits of our space compel us to postpone the conclusion of this article till our next issue. There is abundance in what is here given to reflect upon, especially in what seems the clear evidence that Manhattan Island proper is never destined to hold many more people, probably not over 1,600,000.

National Control of Railways.

There appears in *The Forum* for May a graphic picture, by Mr. FREDERICK TAYLOR, of the evils attendant upon present methods of railway management or mismanagement, and as a suggested cure for them he proposes to do away with all interference with the railways by the several States, and substitute for it a system of control by the United States Government, analogous to the present system of supervision of National Banks.

Mr. TAYLOR has been quick to appreciate the evils of the present system of railroad management, and he describes them each and all, from the point of view of the railway stockholders as well as from that of the general public. The present state of affairs, as he pictures it, is very bad indeed; but while in many points his position is perfectly sound, in others he has made out a far worse case than the facts will warrant. He charges, at the outset, that three-fourths of all the legislative corruption, and half the litigation of the past 50 years, has been due to the railways; but it is to be remembered that the business of railway transportation is so enormous that in proportion to the work done and the interests involved the railways have been no more frequently in the courts than other corporations, and in how many cases have they been forced in by grasping claimants who rely on the popular prejudice against corporations to secure them their case. As for legislation, Mr. TAYLOR himself says, later on: "The average artless bucolic legislator is, of all vessels, the most consuming, and it costs the railroads a world of money every year to stave off the blackmail legislation which comes up in many of the States with painful annual regularity". He lays the blame for every financial panic, for the past 15 years, upon the railroads, and says that "the conversion of competitive roads into vast systems should be regarded with grave concern, to say the least". He quotes from a "prominent London journal" an arraignment of the American railroad system, calling it "the very Sodom and Gomorrah of finance", and making a sweeping general accusation against the railway managers of this country, which shows its absurdity by its extravagance.

But Mr. TAYLOR'S diagnosis of the ills of our present railway system will do no harm. The tendency is rather toward public apathy on the subject than toward an over-estimation of present abuses. It is the remedy he proposes which most needs criticism, for in this, as in other cases it is far easier to see the fault than to remedy it. It would be very reassuring to believe that a supervision of our railway affairs by the general government would prove such a panacea and work such wonders as he supposes, but only a very sanguine temperament can expect it. The plan proposed is in brief to place the control of the railway corporations of the country in the hands of a commission having a life tenure of office (a practical impossibility), and with powers defined by a code of laws. This code, the author suggests, should forbid the construction of any line of railway without consent of the commission, and when built it should be under the supervision of a government engineer. The capitalization of new roads would be restricted to the amount actually expended in construction and equipment. "The commission should establish fair rates for all kinds of railway traffic—fair both to those who use and those who own the roads." The managers should be compelled to run the roads for the best interests of the shareholders, and the "freezing out" of minority holders and scaling down of interest should be stopped.

It is not to be denied that with an ideally perfect code of laws to effect these and similar ends, and a perfectly just administration, the condition of affairs would be vastly improved. But the practical question is whether more wisdom and justice and better acquaintance with the needs of widely separated parts of the country are to be expected in Congress than in State legislatures and from National commissions rather than from State. It should be understood that the present supervision which the government exercises over National banks is child's play compared with the vast task of exercising such a control over the railway transportation interests of the country as is here proposed.

So long as we must depend in any event on such justice and wisdom as human frailties will allow, it seems that we are most likely to obtain it by a proper distribution of power rather than by undue centralization. To a certain extent the local administration by the several States should be subject to appeal to the United States Courts as is now the case; but to place the control of local interests at a point thousands of miles distant from the locality, as when a commission at Washington should decide regarding the building of local lines in Maine or California, seems extremely unwise. The solution of the railroad problem will have to be worked out slowly and to a large extent by experiment. Probably our railway corporations will gradually come more and more under government supervision. City lines will be controlled by the municipality in which they lie; local lines by the several States; and the great systems by the general Government, whose supervision will likewise extend in some degree over the control exercised by the several States.

PERSONAL.

D. W. BOWMAN, formerly with the Phœnixville Bridge Company, is now consulting engineer in charge of bridges on the lines of the Central Railroad & Banking Company of Georgia. The company will erect several large iron bridges during the present season. Mr. BOWMAN'S headquarters are at Savannah, Ga.

R. FRANK HARTFORD, Hydraulic and Sanitary Engineer, of Memphis, Tenn., has been employed to prepare plans for the complete sewerage of Gadsden, Ala. He has just completed plans for the sewerage of North Memphis, Tenn.

COLEMAN SELLERS, for over 32 years connected with the engineering establishment of WILLIAM SELLERS & Co., of Philadelphia, Pa., as engineer and member of the firm, has accepted the chair of Engineering Practice in the Stevens Institute of Technology, at Hoboken. The Stevens Institute has also conferred upon him the title of Doctor of Engineering.

A. F. NIMS has been appointed City Engineer of Nebraska City, Neb.

G. M. CUMMINGS has been appointed General Manager of the St. Joseph & Grand Island R. R.

W. I. ALLEN, Division Superintendent of the Chicago, Kansas & Nebraska R. R., has been appointed General Superintendent. C. DUNLAP will be Division Superintendent.

STEVENSON TOWLE, for 15 years at the head of the Department of Sewers of New York City, has been appointed a member of the Board of Park Commissioners.

CORRESPONDENCE.

Transmission of Power.

OMAHA, Neb., April 27, 1888.

EDITOR ENGINEERING NEWS:—

I have a plan on foot for damming one of our large rivers, which would furnish unlimited power; but the power would be of much more value if it could be transmitted 3 or 6¼ miles, (rise of ground 8 ft. per mile) either by electricity, compressed air through pipes, or by a cable, similar to the working of a street cable railway. The two former methods I am entirely unfamiliar with. I would like to know how they compare in cost and efficiency with the latter, and about what the ratio of loss in power is to distance transmitted; and whether the scheme is feasible by either or any of the above methods. By giving me the above information through the columns of ENGINEERING NEWS, or a hint as to where I can get it, you will greatly oblige.

Yours truly, R. H. LAWRENCE.

[Our correspondent would do well to get some engineer to investigate the whole matter carefully, as much depends on the special conditions, but we apprehend that he would find wire rope transmission the best and compressed air very uneconomical. The Brown Hoisting & Conveying Machine Co., of Cleveland, O., probably have had as much experience in wire rope apparatus of the kind as any one, and write us:

"We can devise a system consisting of several comparatively light wire ropes, instead of a heavy single rope, in which a definite H. P., and no more, could be dropped at any number of given points from any rope. We think several ropes better than one as an accident to one would not stop the entire line, and the contrivance for dropping power at any point is much less expensive than with heavy cable."

Electric transmission of power, however, is becoming of increasing importance, and for transmitting a small amount of power might be more economical, or perhaps for any amount.—ED. ENG. NEWS.]

Making Cuts from Drawings.

Michigan Cent. R. R., Chief Eng.'s Office.

DETROIT, Mich., May 3, 1888.

EDITOR ENGINEERING NEWS:

In the last issue of the NEWS I notice a note in regard to photographing drawings. Who can give the details of this process in its most improved form? Giving cost of outfit, kind of camera, amount of trouble in developing plates, etc.

Yours truly,

J. D. HAWKS, *Chief Engineer.*

[Our correspondent has misunderstood the reference we made to "photographic reproduction" in our issue of April 28. There are now in use many methods of reproducing the artists' work, line for line; and in all of them photography plays an important part.

Two processes now in common use are "Zinc-etching" and the "Mumbler-process."

For "Zinc-etching" a negative of the required size is made from the drawing. This negative is then reversed, and a silver print made from it upon a sheet of type metal. When this print is washed the black lines remain in relief, so that the ink from an ink-roller passed over the surface of the plate, adheres to these lines only. The sheet of metal is now put into a bath of acid, which "bites" away those parts unprotected by the greasy ink, leaving a relief plate from which prints are made as from a wood cut.

In the "Mumbler-process" the print is made directly from the original negative upon a sheet of sensitized gelatine. The parts subjected to light are rendered very hard. The unhardened parts are then washed away by warm water, thus leaving a gelatine model of the cut, from which an electrotype is taken for printing.

There are now a number of firms who pro-

duce cuts by these methods from drawings, at rates varying within wide limits, but depending on the size of the cut and the intricacy of the drawing. An average price might be 20 cents per square inch of area of the finished cut. The cut once made, of course any number of copies may be printed, whenever wanted, by any printer.—ED. ENG. NEWS.]

PUBLICATIONS RECEIVED.

Internal Commerce of the United States. Part II. of Commerce and Navigation. Special report on the Commerce of the Mississippi, Ohio and other rivers, and of the bridges which cross them. Pub. Doc. pp. 591.

Contains a good deal of useful information, especially a full list of the bridges across the Mississippi and Ohio, with cost, spans, and other details of construction, and the usual amount of trash, the value attached to which is indicated by the fact that the book has no index whatever.

The Rose Polytechnic Institute, opened for instruction in 1883, is the gift of the late CHAUNCEY ROSE, Esq., to the city of Terre Haute, Ind., a bequest of half a million of dollars providing for its establishment and support. The equipment of the workshops alone cost forty thousand dollars, and these enable "shop practice" to be made a very prominent feature of the institution.

Especial attention is given to the study of electricity and its applications, for which excellent facilities are provided in the equipment of the extensive laboratories.

The plan of the Institute is to restrict the attendance to such an extent as to realize the benefits arising from small classes.

The Design and Construction of Masonry Dams, giving the Method Employed in Determining the Profile of the Quaker Bridge Dam. By EDWARD WEGMANN, JR., C. E., Am. Soc. C. E., etc. New York, John Wiley & Sons, 1888. Quarto, 106 pp., 59 plates, 24 tables, 16 cuts, good index. Price $5.

We shall notice more fully later this excellent treatise, undoubtedly the best yet published on its subject, which must hereafter be of great service to those having to design high masonry dams. It contains very full information concerning all of the largest dams in the world. The arrangement is excellent, the text being divided into 11 chapters and an appendix, and the paper, type and exterior of the work make it a very handsome volume.

Report of the 21st. Annual Convention of the Master Car-Builders' Association, held at Minneapolis, Minn., June 14-16, 1887. Large 8 vo. pamphlet, 341 pp. 36 folding plates, upwards of 100 cuts, fair index, $1.00.

This admirable report is noticed elsewhere.

Notes on the Compressive Resistance of Freestone, Brick Piers, Hydraulic Cements, Mortars and Concrete. By Gen. Q. A. GILLMOR, Ph. D.; John Wiley & Sons, 1888, 8 vo. 198 pp., many tables, both general and special, 8 strain sheets. $3.50.

The scope and value of this posthumous work of Gen. GILLMORE'S is sufficiently attested by its title page with the added fact that it rests upon new and very careful experiments made at Watertown in 1882, which have only to a limited extent been made public in accessible form heretofore.

Patents. A Primer of Patent Law, for Inventors and Manufacturers. With Tables of Terms of and Fees for Patents in all Patent Granting Countries. By WILLIAM H. FINCKEL, Solicitor of Patents, Washington, D. C.

This is a neat little pamphlet of 36 pages, containing information both interesting and useful. It describes the present organization of the U. S. Patent Office, particulars as to patents, etc.; its scope being defined by its title. Several blank pages for memoranda are added

BOOK REVIEWS.

A Manual of Steam-Boilers by R. H. THURSTON, M. A. Doc., Eng. New York, John Wiley & Son.

Perhaps no one man in the country has done more to put the profession of mechanical engineering on a sound scientific basis and to substitute for the old-fashioned rule of thumb and hit-or-miss methods of the journeyman the accurate designing of the engineer, than the author of this volume. It must be granted, indeed, that much remains to be done in this direction and that very many problems of the mechanical arts are so complex in their nature that the best method of solution is by experiment rather than theory, so that practice is improved and mistakes are rectified by a sort of survival of the fittest, experience teaching what shapes and sizes are too weak and what needlessly strong. But complex problems of another sort, in which appliances of different natures are compared and their ultimate economies ascertained, are far better solved by the careful measurement and examinations of the engineer, and it is to the creation of the profession of mechanical engineering in this country that Prof. THURSTON'S best energies have been devoted.

The work under discussion is certainly a needed one. The steam motor is by far the most important machine in the world and must long remain so. The works on steam generators in the language are all more or less out of date, and most of them make no pretense of treating the subject with any degree of scientific thoroughness. It is of course true that the great majority of steam boilers are designed, constructed and used with satisfaction in the old rule of-thumb manner, but it is also true that in very many cases the economies in operation which might be wrought by a competent mechanical engineer are such as to amply warrant the existence of the profession whose work is daily growing more in demand, as its benefits are understood.

The volume before us opens with a short history of the steam boiler from its earliest forms to the present day. The standard types now in use are considered and the nature of problems in design and the general methods and requirements of correct solution are discussed, with an analysis of the general methods in which further improvements in steam generators must be sought.

Chapter 2 contains 105 pages, and is devoted to "Materials; Strength of Materials and of the Structure". It is a very full and complete treatise on everything relating to the testing and proportioning of all the various parts of the boilers.

Chapter 3 is devoted to fuels and their combustion, and is adapted largely from Prof. THURSTON'S former work on the Materials of Engineering, which is also true of the preceding chapter.

Chapter 4 begins with a discussion of the essential nature of heat, and considers its production, measurement and transfer, with the efficiency of heating surface.

Chapter 5 is devoted to thermodynamics, beginning with an account of RUMFORD'S experiments in this field.

Chapter 6 takes up Steam and its Properties, and Chapter 7, The Design of the Steam Boiler. Here the general nature of the problem is stated as follows:

"*Required:* To determine what type, proportions, size, and construction of boiler may be made, in the location chosen, and under all the natural and artifical conditions found there to exist, to supply a given amount of steam at least total risk and cost."

The author shows his just appreciation of the duties of the mechanical engineer by adding the clause: "The business aspects of the case must be as conscientiously studied by the designing engineer as those of pure engineering."

In Chapter 8, "Problems in Design", the proportions usual for several types of boiler are discussed. Chapter 9 takes up the design of boiler settings, chimneys, steam and water pipes, safety valves, feed apparatus and other accessories of the steam generator. Chapters 10 and 11 are brief and are devoted to the construction of boilers, a condensed statement of modern boiler shop methods, with specifications and contracts. "The Management and Care of Boilers" follows and the subject of scale and corrosion and of boiler coverings is treated here quite fully. In a short chapter of a few pages a mathematical theory of boiler efficiency is given and the final efficiency or measure of the success which the designer of the boiler attains, is called by the author the commercial efficiency and is measured by the ratio of the quantity of steam produced to the total cost of its continuous production. A chapter on "Steam Boiler Trials" contains the standard code for tests adopted by the American Society of Mechanical Engineers, the author being a member of the committee which prepared the code. The concluding chapter on "Steam Boiler Explosions" is already in print as a separate monograph and has been noticed in these columns.

Probably the most serious fault of the volume in practical use is the want of a logical order and system in the arrangement of the matter. It is very largely due to a fault which is conspicuous in many of Prof. THURSTON'S works, not doing enough work in systematizing and arranging the material, combined with one common to many scientific writers, of going to the bottom of every subject and leaving no detail untouched, with a resulting tendency to make each chapter a complete treatise in itself and to repeat the same matter several times over in different chapters. To illustrate: The merits of the various modes of riveting and of welding are discussed at length on pages 123 to 127 also on pages 404 to 413. The use of forced draught is referred to on pages 303, 314, and 448, and by the way, nowhere is the matter of its especial economy taken up. In some of the longer chapters, too, as the one on the strength of the structure, too much space in devoted to statements of elementary facts, as of the different sorts of strain which may be exerted upon materials, and in many places what is interesting reading to a student, anxious to go to the bottom of the matter under discussion, will be little noticed by the practicing engineer who is anxious only to reach the results desired for actual use.

The cuts in the book are generally clear and well printed. Some of those in the chapter on boiler explosions, reproduced from the *Scientific American*, seem rather sensational for a technical treatise and Fig. 124 entitled "An Explosion", representing three burly miners and a sleepy mule waiting for a blast to go off, seems to be hardly necessary to illustrate the author's remark that "the violence of the familiar explosives as used in ordnance, and mining operations, is commonly due to the combined effect of heat and chemical action."

It is in no inappreciative spirit, however, that we make these criticisms. Prof. THURSTON has done much for the cause of science, and he has certainly collected in this volume a large amount of data obtainable nowhere else and of great value to every student and worker in steam engineering. It is a thankless task at best to write a good and worthy book, and the author has done and is doing so much excellent work for the engineering profession that it is easy to overlook the minor faults of the work and congratulate the author upon its real worth.

One other matter it seems not inappropriate to mention here in the interests of justice and correct practice. In a recent review of this same book, one of our contemporaries which would formerly have known better, ventures to criticise certain statements of the author in an absurd way. On page 13 it is said that "The extent of heating surface simply, in all the best forms of boiler, determines the efficiency, and the disposition of that surface seldom affects it to any great extent". The critic misunderstands the meaning of the statement entirely, and declares that furnace heating surface is more efficient than tube heating surface (as everyone knows) and hence that the above is untrue. The context gives no warrant for such an absurd twisting of the sense of the sentence, which as actually written and explained is entirely true.

The second point criticised is in regard to the quality of steam. (Page 15).

"In general it may be said that where the heat and steam are required for the impulsion of an engine, the higher the safe pressure and the practically attainable temperature at which the supply is effected, the more efficient the utilization of the heat. * * * Where heating simply without transformation into work, is intended, the principal and only very important requisite, usually, is to provide such thorough protection for the system of transfer and use, that no wastes of importance can take place by radiation or conduction. The character of the steam made, as to humidity, is in this case comparatively unimportant; but in the preceding case it will be found essential that it should be always dry, and it is often much the better for being superheated above the boiling point due to its pressure."

The reviewer seems surprised at this heresy and says: "In heating, temperature is desired, and the higher the temperature of the medium, the more efficiently and cheaply will the heating be effected." Prof. THURSTON hardly needs defence against such criticisms of his book as this, the nonsense of which will be apparent to any engineer familiar with steam heating apparatus. It would be easy enough to explain the falsity of the critic's position, but it does not seem that it is at all necessary for us to do so in our columns.

Report of the Master Car Builders' Assoc'n, 1887:

It is rather late in 1888 to have the report of a meeting held in June, 1887, appear, only a few weeks before the next annual convention, but the fullness and excellence of the report will go far to excuse this. The M. C. B. Association has never before published half as much matter in any one year, and one feature of it only, the report of the first and second series of Burlington brake tests, makes the report one of quite unique and very great scientific value, and hence one which should be purchased while the edition is unexhausted by those interested in such matters. We shall be greatly surprised if the demand is not such as to soon exhaust it. While the main results of the tests have been quite fully reported in these columns and elsewhere, nowhere else can complete details be found, and complete details are essential to a full understanding of some of the results of the tests. It was largely because of delay in preparing this elaborate report, we understand, that the general report is so much delayed.

The report of the Brake Committee begins with allusion to a fact which it would be well if the Association as a body had more generally appreciated, that in pointing out the need of more elaborate tests in prior reports, "no one of the Committee had realized, even in the most remote way, that the very trials and tests they saw were so indispensable, were at the time within the easiest reach, and that all that was really wanting was action on their own part." The same is true of investigations of many other subjects, as notably steam heating and car-coupling, but the comment is a little too modest in one respect; more was needed than action, viz., a man at the head of the Committee qualified to conduct and ensure the best results from

the tests, and the Brake Committee was fortunate in having such a person at its head in Mr. GODFREY W. RHODES of the C. B. & Q. R. R., to whom individually a large part of the success of the tests is due.

A more important and more useful set of mechanical tests perhaps was never made. In the first place they definitely settled what would otherwise only have been settled by years of useless trouble and expense, that the air brake type was the only one offering promise of usefulness. The various buffer brakes were spending much money and meeting much encouragement, but under the test of practice on a large scale they completely collapsed, with profit to both sides. The second valuable lesson was that the air brake apparatus itself had a fatal defect unless corrected, namely, that it caused terrific shocks, of an entirely inadmissible nature, at the rear of long trains, because of the irregularity in time of application of brakes at front and rear of train. After the first series of tests this defect seemed, to everyone who had taken par in the tests, irremediable except by electric application of brakes, and accordingly the Committee recommended efforts in that direction in their first report. But Mr. GEO. WESTINGHOUSE was not so easily worsted, and after a slight amount of experimenting succeeded in completely eliminating the whole difficulty, so that the brakes went on through the longest train more quickly than sound travels, and the quickest stop was as gentle with 50 cars as with one. No greater mechanical triumph over an entirely unforeseen difficulty was ever achieved by anyone, and except for these tests it might have been only after years of experience and millions of money had been wasted that the same result would have been achieved, if indeed it had been achieved at all. Had Mr. WESTINGHOUSE had a less complete grasp of his subject, or been less disposed to grapple with newer difficulties, it might easily have been that the false premise would have been granted that electricity was necessary, the superfluous complication would have been introduced, and practice would have been fixed, perhaps, forever. No more creditable achievement is contained in the whole list of Mr. WESTINGHOUSE'S great services to engineering than this.

The brake test report occupies about 160 pages of the volume, and is by far its most valuable feature. Most of the folding plates also belong to it. The report of the Executive Committee on a standard automatic freight car coupler, however, recommending the Janney type, was also a most important step in advance, and will make this step long memorable. The report on appliances for the safety of trainmen and on standard sizes of lumber were also of unusual value though short, and herein we have about the full list of the important contents. The full list of the vote on the adoption of the Janney type as a standard has a certain interest. The leading roads which voted "no" were the Boston & Albany, Del. & Hudson, N. Y. Central, Old Colony, Del., Lackawanna & Western, Fitchburg, Rochester & Pittsburg, Central Vermont, Illinois Central, Grand Trunk, and Lehigh Valley. In spite of this formidable list it was carried by 474 against 194, 65 individuals against 35 voting for it.

The list of the M. C. B. standards and the rules for car inspection complete the volume. Many of the first are somewhat antiquated already and but few of them are in anything like general use, illustrating, it seems to us, the unwisdom of attempting to have only one single standard for the whole country in certain details like axles, pedestals, and brasses, where a reasonable diversity, say 3 or 4 standard types of each, would suit all tastes and ensure what does not now seem to be possible, general adherence to the standards laid down; but that is too large a subject to begin discussing at the end of a review.

SOCIETY PROCEEDINGS.

Engineers' Club of Philadelphia, Pa.—The regular meeting was held April 21, President JOSEPH M. WILSON in the chair; 30 members and 1 visitor present. The Secretary announced the gift to the Club, by Mr. JOHN S. NAYLOR, Member, of "Van Nostrand's Engineering Magazine", 1869 to 1886, both inclusive. A vote of thanks was returned to Mr. NAYLOR for this handsome and valuable addition to the Library. Mr. L. F. RONDIELLA presented a series of Steam Formulæ for the Reference Book. Mr. WM. SELLERS presented a paper upon "The Manufacture of Eye Bars for Pin Connected Structures", illustrated by full size test specimen, etc. Mr. JOHN L. GILL, Jr., discussed the desirability of "Expanding in, and of Beading over, Boiler Tubes", and raised the point as to whether beading over was not, in some cases, unnecessary or even injurious. The President announced the following as the Committee to Recommend a Practical Method of Testing Cements, the appointment of which was authorized at Business Meeting, March 17th, 1888, in accordance with the request of Mr. ARTHUR MARICHAL; Messrs. ARTHUR MARICHAL, Chairman, HERBERT BAMBER, Prof. L. M. HAUPT, RUDOLPH HERING and JOHN C. TRAUTWINE, Jr.

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Prof. NIPHER, chairman of the committee to which were referred the communications on national public works, asked the members to present any information they might have on the subject. Copies of Part I from the Council of Engineering Societies were distributed.

Prof. JOHNSON, librarian, reported the completion of an index of the club's books and pamphlets, including publications received by the index department of the association, which had been presented to the club.

Mr. WHEELER read the action of the Engineers' Club of Kansas City on the subject of improvements in highway bridges. The St. Louis club was asked to cooperate in securing needful legislation. On motion the matter was referred to a committee of three. The chair appointed H. A. WHEELER, C. A. SHARMAN and M. G. SCHINKE such committee.

Col. E. D. MEIER read a paper on "The Prall System of Distributing Heat and Power from Central Stations". He called attention to the low efficiency of methods heretofore employed, and gave a detailed description of the Prall system, which he believed offered a solution of many of the difficult problems involved. Water was heated to a high temperature and then pumped through the pipe system at greatly increased pressure. At certain points it was converted into steam or water at lower pressures for heating, power, cooking or other uses. The practical trial of the system at Boston during the past winter had resulted favorably, and extensions were now being planned.

WM. H. BRYAN, *Secretary.*

CONSTRUCTION NEWS.

RAILROADS.

East of Chicago.

Existing Roads.

South Pennsylvania.—One of the most, if not the most, important piece of news of the week in railroad circles is the action taken at the meeting of the stockholders of this company in this city on Wednesday. Out of the $15,000,000 of stock, about $12,300,600 was represented. Among those present were C. H. DUPUY, FRANKLIN B. GOWEN, WM. K. VANDERBILT, COLGATE HOYT, H. H. SHOEMAKER, ANDREW CARNEGIE STEPHEN B. ELKINS, H. F. DIMOCK, H. C. FRICK and F. L. STETSON. Resolutions were adopted providing for the issue of $7,000,000 to represent the amount originally paid in. A 20 per cent. assessment on this is to be made and will be offset by the issue of $3,000,000 of preferred stock. A bond issue of $10,000,000 will also be made. This amount ($13,000,000) it is estimated will suffice to complete and equip the road. The floating of the bonds and the general work in connection with the completion of the enterprise will be under the direction of Messrs. CARNEGIE, HOSTETTER and GOWEN.

Canadian Pacific.—The annual meeting was held in Montreal on May 9. The company now controls a system 4,960 miles in extent. During the year $4,996,616 were expended on construction and equipment. The earnings for the year amount to $11,606,412.80, and the working expenses to $8,102,294. The total estimated value of the company's property is placed at $165,548,810. The earnings are detailed as follows: passengers, $3,453 818; freight, $6,924,130; mails, $241,949; express, $235,035; parlor and sleeping cars, $176,826; telegraph and miscellaneous, $574,653; total, $11,606,412, against $8,368,493 in 1886. The company will build two new grain elevators at Fort William and Owen Sound.

Wheeling & Lake Erie.—The company is marketing a bond issue of $1,500,000 in England for the purpose of building the 40 mile extension from Bowerston, O., to Wheeling, Va.

Ohio & Northwestern.—The city of Ironton, O., is trying to induce the company to build their extension to Portsmouth *via* Ironton.

Ohio & Mississippi.—The company are erecting an extensive machine shop, car shop and round house at Washington, Ind. The present shops, located at Vincennes, Seymour and Cochran, Ind., will be abandoned upon completion of those now in process of construction at Washington, Ind., and all the machinery and the entire force will be concentrated at the new works. The round house will have a capacity sufficient to house 35 locomotives. The dimensions of machine shop and car erecting shop will be 323 ft. by 94 ft. and 134 ft. by 317 ft., respectively. The new grounds embrace an area of 70 acres and are well adapted for the purpose. The buildings will all be of brick of which about 5,000,000 will be used.

Titusville, Cambridge & Lake Erie.—At the annual meeting of this company at Titusville, Pa., on May 7, A. H. STEEL was elected President and ALFRED KELLOG Secretary. It is reported that the road will be extended to Erie.

Dexter & Newport.—It is expected that grading will begin on the extension of this branch of the Maine Central system from Dexter to Dover by June 1.

Lake Shore.—This 15 mile line from Alton Bay to Lacona, N. H., is under survey. It is projected in the Boston & Maine interest.

New Projects and Surveys.

Kingston, Smith's Falls & Ottawa.—A delegation from Kingston and Smith's Falls recently visited Ottawa in the interest of this enterprise. Premier Sir JOHN MCDONALD informed them that no bonuses would be granted this year but that he thought eventually a bonus would be granted to the company. The cost of the line from Kingston to Smith's Falls, 56 miles in length, is estimated at $15,000 per mile. Work will begin at once on obtaining subsidies in the various towns which the line will pass.

Northern Maine.—Chief Engineer DANFORTH will begin the location of this road as soon as the weather permits.

Zealand.—This company has been organized at Littleton, N. H. JAS. E. HENRY is President.

Western Ontario.—This line is projected to run from Port Hope to Inverhuron, On., about 176 miles. Among the promoters of the enterprise are ALEX. MCPHERSON, Montreal, JOHN H. FERGUSON, Toronto, MCLEOD STEWART, Ottawa.

Utica, Adirondack & Saratoga.—This company has been incorporated in New York to build a railway about 20 miles in length from Prospect Station on the Utica & Black River R. R. to West Canada Creek, about 20 miles. Among those interested are RICHARD W. SHERMAN, EDWARD NORRIS, and HENRY C. BALLOU, of Utica; MICHAEL MCDONOUGH of West Troy, WM. T. FINCH of Northwood.

SOUTHERN

Existing Roads.

Central Railroad of Georgia.—This company is to build a large number of iron bridges this year and will let contracts for them soon. The bridge across the Chattahoochie river on the Blakely extension will be one of the largest. It is expected to have the new Columbus & Western line to Birmingham, Ala., open for business in 30 days, and through trains are to be run from Memphis and the West over the Kansas City, Fort Scott & Memphis system. The company has just purchased the East Alabama Railroad and will build the extension to Anniston soon. Work will soon begin on the new line from Savannah west to Americus, a part of which was graded last year by the Savannah, Dublin & Western company.

Cape Fear & Yadkin Valley.—A contract has just been closed with the North State Improvement Company for building the extension from Fayetteville to Wilmington, N. C., at $20,000 per mile of which $10 000 is to be in first mortgage bonds, $5,000 in second mortgage bonds, and $5,000 in the company's stock. Grading is completed on the northwestern extension, to Mt. Airy, N. C.

Norfolk & Western.—The earnings of the Company were for the fourth week in April $97,283, an increase of $26,307; for the month of April, $373,036, an increase of $74,194. The earnings so far this year were $1 520,947, an increase of $321,006.——Tracklaying is in progress on the Flat Top Mountain extension under contractor, H. FAIRFAX.

Louisville & Nashville.—Trains are now running over the Cumberland Gap extension to Pineville, Ky. The work on this extension, which has been very heavy and difficult, has been under the direction of Division Engineer, CHAS. W. STANIFORD.——Preliminary surveys are in progress for an extension from Jellico to Knoxville, Tenn.

Alabama Great Southern.—This company is marketing a bond issue of £276,000 in England, the proceeds of which will be principally used for the purchase of rolling stock.

Tennessee Midland.—The tracklaying is expected to be completed from Memphis to Jackson during the coming week and the line will soon be opened for business. Grading is well along between Jackson and Perryville, and the location is nearly finished on the line to Nashville.

Cincinnati & Green River.—It is reported that surveys will soon be made for an extension of this Kentucky line from Yosemite to Dunnville, about 25 miles. GEO. B. HARPER, Yosemite, Ky., is Superintendent.

Carolina, Cumberland Gap & Chicago.—This South Carolina company has just received aid from townships in Edgefield county, S. C., to the amount of $53,000.

Georgia, Carolina & Northern.—Grading is making rapid progress on this line, which is to run from Monroe, N. C., to Atlanta, Ga. There seems to be a prevailing impression that this line is backed by the Seaboard & Roanoke company and that they will use it as a through line between Atlanta and the North in competition with the Richmond & West Point Terminal and the Central of Georgia.

Silver Springs, Ocala & Gulf.—This Florida road is being pushed on to Homosassa.

New Projects and Surveys.

Atlantic, Birmingham & Kansas City.—A meeting of the projectors of this company was recently held at Macon, Ga. HENRY M. NEWMAN, of New York City, is President; HENRY D. CAPER, of Adairsville, Ga., is Secretary and General Manager. E. C. MACHEN of Macon, who is now completing the Covington & Macon road, is interested in the scheme. This company made several surveys last year; but if we are rightly informed, has never yet been able to raise funds of any amount for construction.

Gulf & Chicago.—This company recently filed articles of incorporation in Illinois for a construction company to build their proposed line in Alabama, Tennessee and Kentucky. C. C. MERRICK, of Chicago, is interested.

Coal Creek & Beech Fork.—Incorporated by E. C. LOCKE, H. M. WILSON, and others, of Coal Creek, Ala., to build a railroad from that point to the Cincinnati Southern Railroad.

Washington & Western.—This Virginia company has elected F. J. KIMBALL, President, and A. J. HEMPHILL, Secretary.

Owensboro, Falls of Rough & Green River.—Owensboro, Ky., has subscribed $75,000 to this enterprise.

Central Valley.—This proposed Kentucky road is to run from a point opposite Madison, Ind., to the Tennessee State line. A. T. KEIGHTLEY, of Greencastle, Ind., is President.

THE NORTHWEST.

Existing Roads.

Chicago, Rock Island & Pacific.—The line surveyed last year from Omaha, Neb., *via* Lincoln and Dewitt to Fairbury, to connect with the Chicago, Kansas & Nebraska division, will probably be built this year. This will give the lines of the C., K. & N. system, in Nebraska and northern Kansas, and the Denver line, a direct outlet to Chicago without the present detour *via* St. Joseph, Mo.

St. Louis, Alton & Terre Haute.—This company is to refund its bonded debt at a lower rate of interest, and with this accomplished there is fair prospect of the stock being able to pay dividends.

Chicago & Northwestern.—Rumors continue to circulate regarding a probable extension to Sault Ste. Marie, but there is little likelihood that the company will parallel the Sault Ste. Marie line for 150 miles through so rough a country as the North Michigan peninsula when its profits by so doing would be largely problematical. Work is in progress on extensions of the Fremont, Elkhorn & Missouri Valley division from Geneva to Superior, Neb., 47 miles, and from Creighton to Verdigris, 12 miles, also on the Wyoming Central extension from Glen Rock to Fort Caspar, 25 miles. The grading contractors are McDonald & Penfield and Dolly & Haines, of Fremont, Neb.

St. Louis, Alton & Springfield.—About 5 miles of this extension to Alton, Ill., have been graded, and tracklaying has begun. It is hoped to complete the line ready for business by July 1. Surveys have just begun for an extension from Bates to Springfield.

St. Paul, Minneapolis & Manitoba.—It is reported that a line will be built this season from Lawrence, Dak., *via* Hillsboro and Ada to Brainerd, Minn.

Minneapolis & Pacific.—It is stated that a line is to be built this year from Glenwood Falls, Minn., direct to Brandon, Manitoba, about 250 miles, and that the Canadian Pacific will furnish the funds for the work. It is possible that the Canadian Pacific intends to revenge itself on the Manitobans for their stubborn fight of a year by diverting the traffic from its Rocky Mountain division, around Manitoba through American territory. It is more probable, however, that rumor has no foundation in fact.

Chicago, Burlington & Quincy.—The reduction of the quarterly dividend on the stock from two to one per cent, has had a very depressing effect on the stock market. There can be no doubt, however, that the move was a wise and conservative one on the part of the management.

Missouri Pacific.—Tracklaying is in progress on the extension from Talmage to Crete, Neb., and the line is expected to be finished to Crete by June 1.

New Projects and Surveys.

St. Paul & Minneapolis Elevated.—This company has been incorporated in Minnesota to build an elevated railway between St. Paul & Minneapolis. The incorporators are E. N. SAUNDERS, A. H. WILDER, F. A. SEYMOUR, WILLIAM DAWSON, Jr., JOHN H. AMES, St. Paul, and JOHN DE LAITTRE, J. F. R. ROSE, C. E. WALES and HENRY SIDLE of Minneapolis.

Hannibal & Omaha.—A convention was held at Kirksville, Mo., on May 1, to discuss the project for a railroad line from Hannibal, Mo., to Omaha, Neb. A committee of six was appointed to incorporate such a road and report at a meeting to be held at Palmyra, Mo., on May 17.

Alaska.—The great scheme for a railroad line to Alaska pops up again with the report that Maj. ROGERS, the Canadian Pacific explorer is to make a trip from Winnipeg to the Pacific coast and thence to Alaska, and that he has been engaged by "a syndicate of American capitalists" to explore for a practical route.

Black River Falls.—A. S. COOPER of Black River Falls, Wis., is making a survey from that point to Sperbeck, to meet a spur road from Mather on the Chicago, Milwaukee & St. Paul.

THE SOUTHWEST.

Existing Roads.

Atchison, Topeka & Santa Fé.—The report which has been telegraphed all over the country that this company had absorbed the whole St. Louis & San Francisco system, deserved much less attention than it received. In the first place it is well known that the two companies have long been on harmonious terms and that they own a number of lines in common, among which is the Atlantic & Pacific. They compete with each other at but few points, and run for the most part in entirely different territory. Such a consolidation as could be effected on such short notice and with such secrecy as was hinted at in the dispatch, would be no great change over the present relation of the companies. It is not at all improbable that eventually the two systems will be operated as one, but the deal is too large and intricate a one to be made in a day and even when made by the officers, it will have to meet with the approval of the owners before it can be accomplished.

The Atchison is surprising its friends by its small earnings when compared with those of a year ago.

The net earnings for March, 1887, were $974,000. This year the net earnings for January, February and March, all combined, amount only to $960,000, or for the three months $14,000 less than for one month last year.

This showing is made, too, on an increased mileage of 576 miles. Perhaps the new Chicago line just opened for traffic will prove such a bonanza as to turn the tide the other way.

Pine Bluff, Monroe & New Orleans.—This Arkansas road has been placed in the hands of a Receiver, Judge FRANK SILVERMAN.

Cleveland, St. Louis & Kansas City.—The company has filed a mortgage for $7,000,000 to the Central Trust Company of New York City.

Kansas City, Wyandotte & Northwestern.—E. W. S. DROUTH, a former superintendent of this road, has brought suit for $65,000 for loans and services, and a receiver has been asked for.

Kansas City & Southern.—Tracklaying is being rapidly pushed between Belton, Mo., and Kansas City and the line will be opened for business by July 1.

San Antonio & Aransas Pass.—The city of Houston, Tex., has granted this company right of way through the city. Grading is in progress and it is intended to have trains running to Houston by July 4. Surveys will probably be made at once on the extension from Houston to Natchez, La.——The negotiations in regard to the subsidies and rights of way for the Austin extension are practically completed and contracts for its construction will be let at once.

St. Louis, Arkansas & Texas.—Articles of incorporation have been filed for a terminal company to build the extension, 90 miles in length, from Malden, Mo., to Grand Tower. This will probably be the next line to be constructed by the company.

Missouri Pacific.—The Bald Knob & Memphis line is now open for business. The Kansas & Arkansas Valley line is completed from VanBuren, Ark., west 48 miles, leaving 23 miles of track still to lay to reach Fort Gibson, Ind. Ter.——By far the most exciting fight now in progress in Wall St., is that which is being waged by the majority stockholders of the Missouri, Kansas & Texas against JAY GOULD. The attempt to throw the International & Great Northern into a receiver's hands was defeated by the opposition, who gave notice that coupons due would be paid on presentation, and a shrewd move, by which a large amount of International & Great Northern securities were brought into the possession of GOULD without the payment of a cent of money, was met by an injunction from Judge BARRETT restraining GOULD'S Missouri, Kansas & Texas directors from further interfering with the stock, and calling on them to show why their recent acts were not illegal and hence void. The annual election of M. K. & T. directors occurs on May 61 and there is every prospect that the GOULD board at present in control will be ousted.

Rio Grande & Eagle Pass.—Work is making good progress on the extension of 25 miles toward Eagle Pass, Tex. It is proposed to raise a subsidy at Eagle Pass to induce the company to complete the line to that point, about 85 miles from the present terminus, this season.

New Projects and Surveys.

West Point.—It is rumored that surveys are to be made for a line of railroad from West Point, Ark., to Des Arc, about 30 miles.

Kansas Valley.—The bill granting this company right of way across the Fort Riley Military reservation in Kansas has been favorably reported by a Congressional committee.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Vancouver, Klickitat & Yakima.—The prospectus of this line, now under construction in Washington Territory, has been received. The line starts from Vancouver, W. T., at the head of ship navigation on the Columbia river, 92 miles from the ocean, and 18 miles from Portland, Ore., a city of 50,000 population. It is proposed to build first the western division of the road from Vancouver to the coal fields about Klickitat Pass, about 75 miles, the line running for 55 miles through heavily timbered lands yielding an average of 75,000 ft. B. M. of timber to the acre, principally yellow fir, pine and cedar. The railroad company owns the lands at Klickitat Pass and have run enough developing tunnels into the seams to test the quality of the coal and its large extent. It is estimated that the company can lay down coal in Portland at a cost of $3.00 per ton. The first 20 miles of the road runs through settled farming country, shipping now 75,000 tons per annum to market. From Klickitat Pass the line is eventually to be pushed through to the wheat fields in Eastern Washington Territory connecting with the Cascade branch of the Northern Pacific at Prosser, while a branch is also proposed direct to Yakima. The first 20 miles of the road are under contract and 5 miles are ready for the rails. The offices of the company are at Vancouver. S. W. BROWN is President, CHAS. BROWN, Vice-President and R. A. HABERSHAM, Chief Engineer.

San Francisco, Clear Lake & Humboldt.—The officers of this California company have induced those who subscribed in aid of the enterprise to grant them a year's extension of time over the date originally set for the completion of the road. They are nowendeavoring to gain an independent entrance to San Francisco. It is denied that Gen. MCNULTA has severed his connection with the enterprise on account of the failure of the negotiations with the San Francisco & Northern Pacific Managers.

Seattle, Lake Shore & Eastern.—The contract for grading the 60 mile section from Spokane Falls, W. T., west to the Big Bend, has been let to Burns & Chapman of Spokane Falls.

Southern Pacific.—Tracklaying is in progress on the Madison, Capay Valley & Clear Lake line. On the Stockton & Tulare line the grading is in progress near Porterville, and the tracklaying is rapidly following up the grading. This road will join the main line at Poso. About 400 hands are now at work on the extension. Surveys are in progress for the line from Fresno to Oakdale.

St. Paul, Minneapolis & Manitoba.—The report that this company and the Northern Pacific had made an agreement to build no extension in Montana this year seems to have little foundation in fact. The washouts on the Manitoba's new line in the Milk river valley have been very numerous, and will take some time to repair. The rails for the line from Helena to Butte, which were shipped early in the spring, have been delayed by the washouts. As soon as the trains can be brought through tracklaying will begin, and all except the 10 miles at the Wickes tunnel will be finished at once, and trains will run to Butte, using the Boulder Valley line of the Northern Pacific till the tunnel is finished.

Northern Pacific.—The last track was laid in the Cascade Tunnel on May 6. Under the name of "The Northern Pacific & Montana," a company has been organized to build eight lines in Montana, with THOS. F. OAKES, FREDERICK BILLINGS and others as the incorporators. The location is about completed of the line from Gallatin to the Helena, Boulder Valley & Butte road, which will give a short route to Butte from the East.

Tehuantepec.—A press dispatch from the city of Mexico states that the contract for the construction of the Tehuantepec Railway has been signed. The road is to be completed in 5 years and the Government will own the road, paying 5 per cent. on the cost. The line will be about 334 kilometres long of which 226 are still to be built.

New Projects and Surveys.

Olympia, Gray's Harbor & Baker's Bay.—This company, whose headquarters are at Olympia, W. T., has elected N. H. OWINGS, President, and JAS. B. HAYDEN, Secretary.

Kit Carson, La Junta & Trinidad.—This projected line is to run from La Junta, Col., to North Platte, Neb., *via* Arlington, Kit Carson and Culbertson.

Monterey & Tampico.—Work has begun on the surveys of this Mexican line. The headquarters of the company are at Monterey, Gen. TREVINO is General Manager. The company has received a heavy subsidy from the Government.

Elk Mountain.—The stockholders of this Colorado company are to meet at Denver on June 5 to vote on a proposition to change the headquarters to Colorado Springs, and to issue bonds for the construction of the road.

San Diego, Old Town & Pacific Beach.—Incorporated in California by E. W. MORSE, THOMAS E. METCALF, J. R. THOMAS and others of San Diego.

Kootenai & Columbia.—This British Columbia company has received a land grant of 200,000 acres.

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Engineers' Club of St. Louis.—The club met May 2, 1888, President HOLMAN in the chair 34 members and 3 visitors present. Prof. A. E. PHILLIPS elected member.

Prof. NIPHER, chairman of the committee to which were referred the communications on national public works, asked the members to present any information they might have on the subject. Copies of Part 1 from the Council of Engineering Societies were distributed.

Prof. JOHNSON, librarian, reported the completion of an index of the club's books and pamphlets, including publications received by the index department of the association, which had been presented to the club.

Mr. WHEELER read the action of the Engineers' Club of Kansas City on the subject of improvements in highway bridges. The St. Louis club was asked to co-operate in securing needful legislation. On motion the matter was referred to a committee of three. The chair appointed H. A. WHEELER, C. A. SHARMAN and M. G. SCHINKE such committee.

Col. E. D. MEIER read a paper on "The Prall System of Distributing Heat and Power from Central Stations". He called attention to the low efficiency of methods heretofore employed, and gave a detailed description of the Prall system, which he believed offered a solution of many of the difficult problems involved. Water was heated to a high temperature and then pumped through the pipe system at greatly increased pressure. At certain points it was converted into steam or water at lower pressures for heating, power, cooking or other uses. The practical trial of the system at Boston during the past winter had resulted favorably, and extensions were now being planned.

WM. H. BRYAN, *Secretary.*

CONSTRUCTION NEWS.

RAILROADS.

East of Chicago.

Existing Roads.

South Pennsylvania.—One of the most, if not the most, important piece of news of the week in railroad circles is the action taken at the meeting of the stockholders of this company in this city on Wednesday. Out of the $15,000,000 of stock, about $12,300,000 was represented. Among those present were C. H. DUPUY, FRANKLIN B. GOWEN, WM. K. VANDERBILT, COLGATE HOYT, H. H. SHOEMAKER, ANDREW CARNEGIE STEPHEN B. ELKINS, H. F. DIMOCK, H. C. FRICK and F. L. STETSON. Resolutions were adopted providing for the issue of $7,000,000 to represent the amount originally paid in. A 20 per cent. assessment on this is to be made and will be offset by the issue of $3,000,000 of preferred stock. A bond issue of $10,000,000 will also be made. This amount ($13,000,000) it is estimated will suffice to complete and equip the road. The floating of the bonds and the general work in connection with the completion of the enterprise will be under the direction of Messrs. CARNEGIE, HOSTETTER and GOWEN.

Canadian Pacific.—The annual meeting was held in Montreal on May 9. The company now controls a system 4,960 miles in extent. During the year $4,996,616 were expended on construction and equipment. The earnings for the year amount to $11,606,412.80, and the working expenses to $8,102,294. The total estimated value of the company's property is placed at $165,548,810. The earnings are detailed as follows: passengers, $3,453 818; freight, $6,924,130; mails, $241,949; express, $235,035; parlor and sleeping cars, $176,826; telegraph and miscellaneous, $574,653; total, $11,606,412, against $8,368,493 in 1886. The company will build two new grain elevators at Fort William and Owen Sound.

Wheeling & Lake Erie.—The company is marketing a bond issue of $1,500,000 in England for the purpose of building the 40 mile extension from Bowerston, O., to Wheeling, Va.

Ohio & Northwestern.—The city of Ironton, O., is trying to induce the company to build their extension to Portsmouth via Ironton.

Ohio & Mississippi.—The company are erecting an extensive machine shop, car shop and round house at Washington, Ind. The present shops, located at Vincennes, Seymour and Cochran, Ind., will be abandoned upon completion of those now in process of construction at Washington, Ind., and all the machinery and the entire force will be concentrated at the new works. The round house will have a capacity sufficient to house 35 locomotives. The dimensions of machine shop and car erecting shop will be 323 ft. by 94 ft. and 134 ft. by 317 ft., respectively. The new grounds embrace an area of 70 acres and are well adapted for the purpose. The buildings will all be of brick of which about 5,000,000 will be used.

Titusville, Cambridge & Lake Erie.—At the annual meeting of this company at Titusville, Pa., on May 7, A. H. STEEL was elected President and ALFRED KELLOG Secretary. It is reported that the road will be extended to Erie.

Dexter & Newport.—It is expected that grading will begin on the extension of this branch of the Maine Central system from Dexter to Dover by June 1.

Lake Shore.—This 15 mile line from Alton Bay to Laconia, N. H., is under survey. It is projected in the Boston & Maine interest.

New Projects and Surveys.

Kingston, Smith's Falls & Ottawa.—A delegation from Kingston and Smith's Falls recently visited Ottawa in the interest of this enterprise. Premier Sir JOHN MCDONALD informed them that no bonuses would be granted this year but that he thought eventually a bonus would be granted to the company. The cost of the line from Kingston to Smith's Falls, 56 miles in length, is estimated at $15,000 per mile. Work will begin at once on obtaining subsidies in the various towns which the line will pass.

Northern Maine.—Chief Engineer DANFORTH will begin the location of this road as soon as the weather permits.

Zealand.—This company has been organized at Littleton, N. H. JAS. E. HENRY is President.

Western Ontario.—This line is projected to run from Port Hope to Inverhuron, On., about 176 miles. Among the promoters of the enterprise are ALEX. MCPHERSON, Montreal, JOHN H. FERGUSON, Toronto, MCLEOD STEWART, Ottawa.

Utica, Adirondack & Saratoga.—This company has been incorporated in New York to build a railway about 20 miles in length from Prospect Station on the Utica & Black River R. R. to West Canada Creek, about 20 miles. Among those interested are RICHARD W. SHERMAN, EDWARD NORRIS, and HENRY C. BALLOU, of Utica; MICHAEL MCDONOUGH of West Troy, WM. T. FINCH of Northwood.

SOUTHERN

Existing Roads.

Central Railroad of Georgia.—This company is to build a large number of iron bridges this year and will let contracts for them soon. The bridge across the Chattahoochie river on the Blakely extension will be one of the largest. It is expected to have the new Columbus & Western line to Birmingham, Ala., open for business in 30 days, and through trains are to be run from Memphis and the West over the Kansas City, Fort Scott & Memphis system. The company has just purchased the East Alabama Railroad and will build the extension to Anniston soon. Work will soon begin on the new line from Savannah west to Americus, a part of which was graded last year by the Savannah, Dublin & Western company.

Cape Fear & Yadkin Valley.—A contract has just been closed with the North State Improvement Company for building the extension from Fayetteville to Wilmington, N. C., at $20,000 per mile of which $10 000 is to be in first mortgage bonds, $5,000 in second mortgage bonds, and $5,000 in the company's stock. Grading is completed on the northwestern extension, to Mt. Airy, N. C.

Norfolk & Western.—The earnings of the Company were for the fourth week in April $97,283, an increase of $26,307; for the month of April, $373,036, an increase of $74,194. The earnings so far this year were $1 520,947, an increase of $321,006.——Tracklaying is in progress on the Flat Top Mountain extension under contractor, H. FAIRFAX.

Louisville & Nashville.—Trains are now running over the Cumberland Gap extension to Pineville, Ky. The work on this extension, which has been very heavy and difficult, has been under the direction of Division Engineer, CHAS. W. STANIFORD.——Preliminary surveys are in progress for an extension from Jellico to Knoxville, Tenn.

Alabama Great Southern.—This company is marketing a bond issue of £276,000 in England, the proceeds of which will be principally used for the purchase of rolling stock.

Tennessee Midland.—The tracklaying is expected to be completed from Memphis to Jackson during the coming week and the line will soon be opened for business. Grading is well along between Jackson and Perryville, and the location is nearly finished on the line to Nashville.

Cincinnati & Green River.—It is reported that surveys will soon be made for an extension of this Kentucky line from Yosemite to Dunnville, about 25 miles. GEO. B. HARPER, Yosemite, Ky., is Superintendent.

Carolina, Cumberland Gap & Chicago.—This South Carolina company has just received aid from townships in Edgefield county, S. C., to the amount of $53,000.

Georgia, Carolina & Northern.—Grading is making rapid progress on this line, which is to run from Monroe, N. C., to Atlanta, Ga. There seems to be a prevailing impression that this line is backed by the Seaboard & Roanoke company and that they will use it as a through line between Atlanta and the North in competition with the Richmond & West Point Terminal and the Central of Georgia.

Silver Springs, Ocala & Gulf.—This Florida road is being pushed on to Homosassa.

New Projects and Surveys.

Atlantic, Birmingham & Kansas City.—A meeting of the projectors of this company was recently held at Macon, Ga. HENRY M. NEWMAN, of New York City, is President; HENRY D. CAPER, of Adairsville, Ga., is Secretary and General Manager. E. C. MACHEN of Macon, who is now completing the Covington & Macon road, is interested in the scheme. This company made several surveys last year; but if we are rightly informed, has never yet been able to raise funds of any amount for construction.

Gulf & Chicago.—This company recently filed articles of incorporation in Illinois for a construction company to build their proposed line in Alabama, Tennessee and Kentucky. C. C. MERRICK, of Chicago, is interested.

Coal Creek & Beech Fork.—Incorporated by E. C. LOCKE, H. M. WILSON, and others, of Coal Creek, Ala., to build a railroad from that point to the Cincinnati Southern Railroad.

Washington & Western.—This Virginia company has elected F. J. KIMBALL, President, and A. J. HEMPHILL, Secretary.

Owensboro, Falls of Rough & Green River.—Owensboro, Ky., has subscribed $75,000 to this enterprise.

Central Valley.—This proposed Kentucky road is to run from a point opposite Madison, Ind., to the Tennessee State line. A. T. KEIGHTLEY, of Greencastle, Ind., is President.

THE NORTHWEST.

Existing Roads.

Chicago, Rock Island & Pacific.—The line surveyed last year from Omaha, Neb., *via* Lincoln and Dewitt to Fairbury, to connect with the Chicago, Kansas & Nebraska division, will probably be built this year. This will give the lines of the C., K. & N. system, in Nebraska and northern Kansas, and the Denver line, a direct outlet to Chicago without the present detour *via* St. Joseph, Mo.

St. Louis, Alton & Terre Haute.—This company is to refund its bonded debt at a lower rate of interest, and with this accomplished there is fair prospect of the stock being able to pay dividends.

Chicago & Northwestern.—Rumors continue to circulate regarding a probable extension to Sault Ste. Marie, but there is little likelihood that the company will parallel the Sault Ste. Marie line for 150 miles through so rough a country as the North Michigan peninsula when its profits by so doing would be largely problematical. Work is in progress on extensions of the Fremont, Elkhorn & Missouri Valley division from Geneva to Superior, Neb., 47 miles, and from Creighton to Verdigris, 12 miles, also on the Wyoming Central extension from Glen Rock to Fort Caspar, 25 miles. The grading contractors are McDonald & Penfield and Dolly & Haines, of Fremont, Neb.

St. Louis, Alton & Springfield.—About 5 miles of this extension to Alton, Ill., have been graded, and tracklaying has begun. It is hoped to complete the line ready for business by July 1. Surveys have just begun for an extension from Bates to Springfield.

St. Paul, Minneapolis & Manitoba.—It is reported that a line will be built this season from Lawrence, Dak., *via* Hillsboro and Ada to Brainerd, Minn.

Minneapolis & Pacific.—It is stated that a line is to be built this year from Glenwood Falls, Minn., direct to Brandon, Manitoba, about 250 miles, and that the Canadian Pacific will furnish the funds for the work. It is possible that the Canadian Pacific intends to revenge itself on the Manitobans for their stubborn fight of a year by diverting the traffic from its Rocky Mountain division, around Manitoba through American territory. It is more probable, however, that rumor has no foundation in fact.

Chicago, Burlington & Quincy.—The reduction of the quarterly dividend on the stock from two to one per cent, has had a very depressing effect on the stock market. There can be no doubt, however, that the move was a wise and conservative one on the part of the management.

Missouri Pacific.—Tracklaying is in progress on the extension from Talmage to Crete, Neb., and the line is expected to be finished to Crete by June 1.

New Projects and Surveys.

St. Paul & Minneapolis Elevated.—This company has been incorporated in Minnesota to build an elevated railway between St. Paul & Minneapolis. The incorporators are E. N. SAUNDERS, A. H. WILDER, F. A. SEYMOUR, WILLIAM DAWSON, Jr., JOHN H. AMES, St. Paul, and JOHN DE LAITTRE, J. F. R. ROSE, C. E. WALES and HENRY SIDLE of Minneapolis.

Hannibal & Omaha.—A convention was held at Kirksville, Mo., on May 1, to discuss the project for a railroad line from Hannibal, Mo., to Omaha, Neb. A committee of six was appointed to incorporate such a road and report at a meeting to be held at Palmyra, Mo., on May 17.

Alaska.—The great scheme for a railroad line to Alaska pops up again with the report that Maj. ROGERS, the Canadian Pacific explorer is to make a trip from Winnipeg to the Pacific coast and thence to Alaska, and that he has been engaged by "a syndicate of American capitalists" to explore for a practical route.

Black River Falls.—A. S. COOPER of Black River Falls, Wis., is making a survey from that point to Sperbeck, to meet a spur road from Mather on the Chicago, Milwaukee & St. Paul.

THE SOUTHWEST.

Existing Roads.

Atchison, Topeka & Santa Fé.—The report which has been telegraphed all over the country that this company had absorbed the whole St. Louis & San Francisco system, deserved much less attention than it received. In the first place it is well known that the two companies have long been on harmonious terms and that they own a number of lines in common, among which is the Atlantic & Pacific. They compete with each other at but few points, and run for the most part in entirely different territory. Such a consolidation as could be effected on such short notice and with such secrecy as was hinted at in the dispatch, would be no great change over the present relation of the companies. It is not at all improbable that eventually the two systems will be operated as one, but the deal is too large and intricate a one to be made in a day and even when made by the officers, it will have to meet with the approval of the owners before it can be accomplished.

The Atchison is surprising its friends by its small earnings when compared with those of a year ago.

The net earnings for March, 1887, were $974,000. This year the net earnings for January, February and March, all combined, amount only to $960,000, or for the three months $14,000 less than for one month last year.

This showing is made, too, on an increased mileage of 576 miles. Perhaps the new Chicago line just opened for traffic will prove such a bonanza as to turn the tide the other way.

Pine Bluff, Monroe & New Orleans.—This Arkansas road has been placed in the hands of a Receiver, Judge FRANK SILVERMAN.

Cleveland, St. Louis & Kansas City.—The company has filed a mortgage for $7,000,000 to the Central Trust Company of New York City.

Kansas City, Wyandotte & Northwestern.—E. W. S. DROUTH, a former superintendent of this road, has brought suit for $65,000 for loans and services, and a receiver has been asked for.

Kansas City & Southern.—Tracklaying is being rapidly pushed between Belton, Mo., and Kansas City and the line will be opened for business by July 1.

San Antonio & Aransas Pass.—The city of Houston, Tex., has granted this company right of way through the city. Grading is in progress and it is intended to have trains running to Houston by July 4. Surveys will probably be made at once on the extension from Houston to Natchez, La.——The negotiations in regard to the subsidies and rights of way for the Austin extension are practically completed and contracts for its construction will be let at once.

St. Louis, Arkansas & Texas.—Articles of incorporation have been filed for a terminal company to build the extension, 90 miles in length, from Malden, Mo., to Grand Tower. This will probably be the next line to be constructed by the company.

Missouri Pacific.—The Bald Knob & Memphis line is now open for business. The Kansas & Arkansas Valley line is completed from VanBuren, Ark., west 48 miles, leaving 23 miles of track still to lay to reach Fort Gibson, Ind. Ter.——By far the most exciting fight now in progress in Wall St., is that which is being waged by the majority stockholders of the Missouri, Kansas & Texas against JAY GOULD. The attempt to throw the International & Great Northern into a receiver's hands was defeated by the opposition, who gave notice that coupons due would be paid on presentation, and a shrewd move, by which a large amount of International & Great Northern securities were brought into the possession of GOULD without the payment of a cent of money, was met by an injunction from Judge BARRETT restraining GOULD'S Missouri, Kansas & Texas directors from further interfering with the stock, and calling on them to show why their recent acts were not illegal and hence void. The annual election of M. K. & T. directors occurs on May 61 and there is every prospect that the GOULD board at present in control will be ousted.

Rio Grande & Eagle Pass.—Work is making good progress on the extension of 25 miles toward Eagle Pass, Tex. It is proposed to raise a subsidy at Eagle Pass to induce the company to complete the line to that point, about 83 miles from the present terminus, this season.

New Projects and Surveys.

West Point.—It is rumored that surveys are to be made for a line of railroad from West Point, Ark., to Des Arc, about 30 miles.

Kansas Valley.—The bill granting this company right of way across the Fort Riley Military reservation in Kansas has been favorably reported by a Congressional committee.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Vancouver, Klickitat & Yakima.—The prospectus of this line, now under construction in Washington Territory, has been received. The line starts from Vancouver, W. T., at the head of ship navigation on the Columbia river, 92 miles from the ocean, and 18 miles from Portland, Ore., a city of 50,000 population. It is proposed to build first the western division of the road from Vancouver to the coal fields about Klickitat Pass, about 75 miles, the line running for 55 miles through heavily timbered lands yielding an average of 75,000 ft. B. M. of timber to the acre, principally yellow fir, pine and cedar. The railroad company owns the lands at Klickitat Pass and have run enough developing tunnels into the seams to test the quality of the coal and its large extent. It is estimated that the company can lay down coal in Portland at a cost of $3.00 per ton. The first 20 miles of the road runs through settled farming country, shipping now 75,000 tons per annum to market. From Klickitat Pass the line is eventually to be pushed through to the wheat fields in Eastern Washington Territory connecting with the Cascade branch of the Northern Pacific at Prosser, while a branch is also proposed direct to Yakima. The first 20 miles of the road are under contract and 5 miles are ready for the rails. The offices of the company are at Vancouver. S. W. BROWN is President, CHAS. BROWN, Vice-President and R. A. HABERSHAM, Chief Engineer.

San Francisco, Clear Lake & Humboldt.—The officers of this California company have induced those who subscribed in aid of the enterprise to grant them a year's extension of time over the date originally set for the completion of the road. They are nowendeavoring to gain an independent entrance to San Francisco. It is denied that Gen. MCNULTA has severed his connection with the enterprise on account of the failure of the negotiations with the San Francisco & Northern Pacific Managers.

Seattle, Lake Shore & Eastern.—The contract for grading the 60 mile section from Spokane Falls, W. T., west to the Big Bend, has been let to Burns & Chapman of Spokane Falls.

Southern Pacific.—Tracklaying is in progress on the Madison, Capay Valley & Clear Lake line. On the Stockton & Tulare line the grading is in progress near Porterville, and the tracklaying is rapidly following up the grading. This road will join the main line at Poso. About 400 hands are now at work on the extension. Surveys are in progress for the line from Fresno to Oakdale.

St. Paul, Minneapolis & Manitoba.—The report that this company and the Northern Pacific had made an agreement to build no extension in Montana this year seems to have little foundation in fact. The washouts on the Manitoba's new line in the Milk river valley have been very numerous, and will take some time to repair. The rails for the line from Helena to Butte, which were shipped early in the spring, have been delayed by the washouts. As soon as the trains can be brought through tracklaying will begin, and all except the 10 miles at the Wickes tunnel will be finished at once, and trains will run to Butte, using the Boulder Valley line of the Northern Pacific till the tunnel is finished.

Northern Pacific.—The last track was laid in the Cascade Tunnel on May 6. Under the name of "The Northern Pacific & Montana," a company has been organized to build eight lines in Montana, with THOS. F. OAKES, FREDERICK BILLINGS and others as the incorporators. The location is about completed of the line from Gallatin to the Helena, Boulder Valley & Butte road, which will give a short route to Butte from the East.

Tehuantepec.—A press dispatch from the city of Mexico states that the contract for the construction of the Tehuantepec Railway has been signed. The road is to be completed in 5 years and the Government will own the road, paying 5 per cent. on the cost. The line will be about 334 kilometres long of which 236 are still to be built.

New Projects and Surveys.

Olympia, Gray's Harbor & Baker's Bay.—This company, whose headquarters are at Olympia, W. T., has elected N. H. OWINGS, President, and JAS. B. HAYDEN, Secretary.

Kit Carson, La Junta & Trinidad.—This projected line is to run from La Junta, Col., to North Platte, Neb., *via* Arlington, Kit Carson and Cuibertson.

Monterey & Tampico.—Work has begun on the surveys of this Mexican line. The headquarters of the company are at Monterey, Gen. TREVINO is General Manager. The company has received a heavy subsidy from the Government.

Elk Mountain.—The stockholders of this Colorado company are to meet at Denver on June 5 to vote on a proposition to change the headquarters to Colorado Springs, and to issue bonds for the construction of the road.

San Diego, Old Town & Pacific Beach.—Incorporated in California by E. W. MORSE, THOMAS E. METCALF, J. R. THOMAS and others of San Diego.

Kootenai & Columbia.—This British Columbia company has received a land grant of 200,000 acres.

Contracting.

Reservoir.—The contract for building the reservoir at Columbus, S. C., has been awarded to James F. Troy for $6,949.50.

Granite.—Cranford & Valentine, the contractors for the new reservoirs at Albany, N. Y., for the new water supply of that city, have sublet the contract for granite to a Maine firm, which will furnish the stone, cut at the quarry, as desired. The amount needed is 250,000 cu. ft. This includes between $20,000 and $25,000 worth of dressed stone.

Dredging at Chicago.—City Engineer NORTHWAY, of Chicago, speaking of the low stage of the water to a *Tribune* reporter, says the following: "The effects of this low stage of water are to be felt at almost every port on the lakes, but nowhere will they be more demoralizing than in the Chicago river. We have $40,000 with which to dredge the river, whereas we need $100,000. We will try and make a good channel in the main branch from Wells Street to Rush, with a passage way on each side, so that vessels can go up one side and down the other. We will be unable to do much at Wells Street until the bridge is completed, but the south draws of State and Clark Street bridges will be dredged out. Dearborn Street is already in shape. Having 2 channels for deep-draft boats will lessen the liability to blockades in the main branch and help out some. No thorough dredging has been done for five years, and the draws are getting pretty well filled up. The balance of the appropriation will be expended in the spots most needing it."

Cypress Block Paving.—A contract for cypress block paving has been awarded by the Street Committee, Savannah, Ga., to Matthew Hayes, of Jacksonville, Fla. This is for experiment. Pine blocks were tried in 1870, and were taken up a couple of years afterward in a rotten condition, and the pavement was discarded. Cypress pavement has been in use for three years in Jacksonville, and is reported to be wearing very well. Mr. Hayes expressed his willingness to guarantee the blocks to be free from sap and to lay them at $1.20 per sq. yd., 85 cts. to be paid when the paving is completed, and 35 cts. at the end of two years if the paving is found durable. This would be a saving of $1.15 per sq. yd. over asphalt, and it is claimed that vehicles make less noise over the cypress pavement than on the asphalt. Mr. Hayes is also willing to lay 200 sq. yds. of the cypress blocks free of charge where they will be tested by heavy travel. The committee will accept this proposition, but it has not yet been determined where this will be put down.

Depots.—The contract for building a new freight transfer station at West Albany, N. Y., for the New York Central R. R., has been awarded to James Ackroyd, of Albany. It is to be 600 ft. long and 50 ft. wide, and will cost $27,000.——The contract for building the West Shore R. R. station at Wiehawken, N. J., to replace the one destroyed by fire April 7, has been awarded to Austin Gibbins, of New York City.

The Chicago Forge & Bolt Co. has removed its office to Room 701, Rookery Building, Chicago.

Toledo, Saginaw & Mackinaw R. R.—G. T. Wiswell, of Chicago, has been awarded the contract for 50 miles of track laying and ballasting on the Saginaw Division. McRae, Lally & Son are doing the grading and have about 28 miles graded. M. Shoulders, of Port Huron, Mich., has the contract for fencing. The Detroit Bridge & Iron Co., of Detroit, Mich., is building the iron bridges across Cass river, Flint river and Coal creek. WM. DOHENY, of East Saginaw, Mich., is Superintendent of Construction for the Saginaw Construction Co.

Street Lighting.—At Merchantville, N. J., only one proposal for gas works and for electric light plant was received May 1 by the Gas Committee, in answer to its advertisement. Having had several inquiries, however, asking for full particulars, it has been resolved not to decide until the meeting on June 5, in order to give others an opportunity of making proposals. The committee will hold strictly confidential all propositions for street lighting per post per year, and price per 1,000 cu. ft. to consumers.

Dams.—Three or four dams will be built by the Mammoth Spring Water Power & Improvement Co., of Mammoth Spring, Ark.

Street Railways.—*Waterville, Me.*—The contract for the Waterville & Fairfield street railway has been awarded to Soule & Co., of Boston.

Wareham, Mass.—The contract for the East Wareham, Onset Bay and Point Independence street railway has been awarded to Chas. McDermott, of Falmouth.

Syracuse, N. Y.—The contract for the Peoples' street railway has been awarded to Hathaway & Robinson, of Cleveland, O.

Creosoting Plant.—As the State Board of Harbor Commissioners, of California, have not the authority to erect creosote works for the purpose of preparing piles for the water front, an endeavor is being made to interest private capital, so as to have creosote works put in operation at San Francisco. The plant, including ground, machinery, and a sufficient stock of creosote and piles to commence work, would cost about $55,000. The machinery alone would cost $35,000.

Timber & Bolts.—The following proposals for materials for constructing a crib in Spuyten Duyvil creek for the Harlem river improvement, were opened May 3, by Lt. Col. G. L. GILLESPIE, U. S. Engineer Office, New York City: John Timmes, Brooklyn, N. Y., drift bolts, 2.4 cts. per lb., $480; Rowland A. Robbins, New York City, 2.44 cts., $488; Enoch L. Richardson, New York City, round spruce and hemlock timber, 5¾ cts. per lin. ft.; square Georgia pine timber, $25 per 1,000 ft. B. M.; total, $2,597.25; James D. Leary, New York City, 5¾ cts., $29, $2,852.25; Geo. Karr & Co., New York City, 6 cts., $24, $2,868; James DuBois, New York City, 6¼ cts., $25, 3 cts. per lb. for drift bolts, $3,587.50. Contracts were awarded to E. L. Richardson for timber and John Timmes for bolts.

Water-Works Supplies.—The Committee on Water-Works, Toronto, Ont., has awarded contracts as follows for material for 1888: St. Lawrence Foundry Co., Toronto, 3, 6 and 12-in. cast-iron pipe, $44.80, $38 and $37.50; scrap, $14.50 for cast and $11.95 for wrought iron; also for fountains, horse troughs and iron stop boxes. Chas. Smith & Co., Toronto, valves and hydrants. Rice, Lewis & Son, Toronto, pig lead, $3.89 per 100 lbs. James Robertson & Co., Toronto, lead pipe, $4.75 per 100 lbs. Thos. W. Self, Toronto, brick meter chambers, $15.90 per 1000 brick. Treloar, Blashford & Co., Toronto, special castings, $2.25 per 100 lbs. Burns & McCormack, Toronto, brass work.

Pumping Machinery.—The following proposals have been received by the Water Committee, Allegheny, Pa., for engines of 36-in. and 48-in. stroke: Wilson, Snyder & Co., (36-in.) $42,000, (48-in.) $45,000. Geo. F. Blake Mfg. Co., New York, (36-in.) $43,450, (48-in.) $54,600. Henry R. Worthington, New York, (36-in.) $58,600 and $42,200, (48-in.) $46,000. Gordon & Maxwell Mfg. Co., Hamilton, O., (36-in.) $40,000. Holly Mfg. Co., Lockport, N. Y., (36 in.) $70,000, $38,000 and $36,000.

Reservoirs.—*Portland, Me.*—The contract for the construction of the reservoir on Munjoy Hill has been awarded to James Newman, of Providence, R. I.

Uniontown, Pa.—The water company has awarded the contract for the 5,000,000 galls. reservoir, and laying pipe to the town, to Wm. Turner and Robert Boyd.

Sewers.—*East Liverpool, O.*—The contract for the construction of the sewers has been awarded to Thomas Connell, of Youngstown, O., at the following prices: laying 4, 6, 8 and 10-in. pipe, 4, 5, 6½ and 7 cts.; 62,750 ft. of excavation and back filling, from 6 cts. for under 2 ft. to $2 for 17 to 18 ft. deep; concrete, $4.50 per cu. yd.; rock, $2.50 per cu. yd.; 200 inspection pipes, $3 each; 41 flush tanks, $26.40 each; 6 manholes, $37 each; laying 10-in. iron pipe for outlet, $1.08 per ft.; piles, 35 cts. per ft.; 10 flushing manholes, $15 each; furnishing and laying 1½-in. to 6-in. tile, 2 to 5 cts. per ft.; laying iron pipe, 15 to 28 cts. per ft.; total, $24,030. The contract for sewer pipe and specials was awarded to Knowles, Taylor & Anderson, of East Liverpool, at 55% discount; for cast-iron pipe and specials, to Andrew J. Boyce, of East Liverpool, at $26.70 per ton per pipe and 2¼ cts. per lb. for specials; for Portland cement, to Miller & Sons, of Warners, N. Y., $2 per bbl.; for brick, to W. S. Smith & Co., of East Liverpool, at $8 per 1,000. The bidders for construction were: Thomas Connell, Youngstown, O., $24,030; W. M. Chisholm, East Liverpool, $28,155; J. J. Everson and James Christy, Jr., Akron, $30,039.50; Coon & Co., Washington, Pa., $30,629.50; Frank Riley & James F. Kuntz, Cleveland, O., $32,020; Allen & Franklin, Buffalo, N. Y., $35,069.38; Richard Dickson, Sault Ste. Marie, Mich., $38,199; T. C. Brooks & Co., Detroit, Mich., $41,399.50; C. H. Voute, Toledo, O., $43,901; J. C. Murray, Newark, O., $49,410; H. C. Howard & Co., $64,773.50.

San Buenaventura, Cal.—The contract for sewers has been awarded by GEO. C. POWER, City Engineer, to Hobson, Wilkerson & Hobson at the following prices: cast-iron pipe, 2.98 cts. per lb. for 14-in., 2.98 cts. for 12-in. and 3 cts. for 12-in. curved; vitrified salt glazed sewer pipe, from 24 cts. for 6-in. to 89 cts. for 14-in.; Y's, from 70 cts. for 6 × 4 to $2.48 for 14 × 6; laying cast-iron pipe out into the ocean, $1.50 and $2.25 per ft.; manholes, $59; lampholes, $6; iron flush tank, $85; brick flush tank, $64 (these do not include the flushing apparatus); total, $18,765.90. There will be 500 ft. of 14-in. and 32 ft. of 12-in. cast-iron pipe, and 15,730 ft. of tile. The outlet consists of 14-in. cast-iron pipe, with flange joint, 120 lbs. per ft., laid into the breakers in about 3 ft. of water at very low tide. The trenching will average about 6 ft. in sand, heavy soil and loose boulders. Some water in trenches and probably some quicksand.

The Pond Engineering Co., of St. Louis, Mo., has issued an illustrated catalogue of improved steam and hydraulic machinery, including numerous types of engines, boilers and pumps; also injectors, indicators, gauges, filters, steam fittings, grates, etc. Tables of dimensions, capacities, etc., are given. The catalogue forms a pamphlet of 145 pages.

Lighthouse.—The following proposals for the lighthouse and metal work of the Castle Hill light station, Rhode Island, were opened May 5, by Maj. D. V. HEAP, U. S. A., Tompkinsville, N. Y.: Lighthouse: Murphy & Hayden, New York, $14,300; Chas. Sundberg & Co., Chicago, Ill., $16,000. Metal work: Builders' Iron Foundry, Providence, R. I., $2,595; Phœnix Iron Co., Trenton, N. J. $2,750; C. Rittenhouse & Sons, Norristown, Pa., $1,114.31; Chas. Sundberg & Co., Chicago, $5,000.

City Improvements.—At Nebraska City, Neb., an extensive system of sewers and drainage will be commenced shortly. Contracts will also be let for a considerable amount of paving. A. F. NIMS is City Engineer.

Proposals Open.

Street Railway Material.—Iron rails, cars, engines, etc, NAT. ATKINSON, Asheville, N. C.

Railway.—Ballasting with sand, raising, surfacing and lining track and raising bridges and cattle-guards for a distance of 11.1 miles of the Natchitoches R. R., between Prudhomme and Natchitoches, La. L. CASPARI, President, Natchitoches R. R. Co., 76 Baronne St., New Orleans, La. May 12.

Wharf.—Wharf, 2,000 ft.; trestle approach, 1,000 ft.; freight shed, 40 × 90 ft.: 2,300 piles; preservation of piles by paraffine preparation; 1,100,000 ft. of Oregon pine; spikes and other iron work; driving piles, etc. Bids for the whole work or parts of same. SAN DIEGO LAND & TOWN Co., National City, Cal. May 15.

State Reformatory.—At St. Cloud, Minn. Architect, J. WALTER STEVENS, 501 Drake Block, St. Paul. The proposals to be for excavation, stone and brick masonry, cement and concreting, cut stone work, structural iron work, cell work and window guards, roofing, carpentry and joiner work, asphalt floors, plumbing, steam heating, painting and glazing. The proposals to be in bulk sum for the different parts. GORDON E. COLE, 348 Jackson St., St. Paul, Minn. May 15.

Masonry, Floor Tiling, Etc.—Repaving the concrete walk and repairing the sea wall at the Battery; building foundation walls at Morningside Park. Also floor tiling at the Metropolitan Museum of Art. THE PARKS COMMISSIONERS, 49, 51 Chambers St., New York City. May 16.

Bridge.—Renewal of the wood superstructure of the east approach of the Central bridge over the Harlem river. The PARKS COMMISSIONERS, 49, 51 Chambers St., New York City. May 16.

Tunnels.—Two tunnels, 850 and 1,000 ft. long, both 11 × 14; near Knights Ferry. Plans with the chief engineer, at Knights Ferry. A. M. NOBLE, Secretary, San Joaquin Land & Water Co., Stockton, Cal. May 17.

Pier Work.—Repairing pier and crib bulkheads at W. 11th St., North River. THE DOCK COMMISSIONERS, Pier A, North River, New York City. May 17.

Court House.—At Tecumseh, Neb. Architect, WM. GRAY, of Lincoln, Neb. J. L. YOUNG, County Clerk, Tecumseh, Neb. May 18.

Sewers.—Storm water sewers. Brick sewer, 1,325 ft. of 7½ ft.; 1,000 ft. of 5½ ft.; 600 ft. of 4½ ft.; 750 ft. of 15-in. pipe sewer; 600 ft. of 12-in. inlet pipe; 22 catch basins; 4 manholes; 2,000 ft. of oak piling and 5,000 ft. of oak lumber; also concrete, rubble stone, etc. City engineer's estimate, $32,125. J. W. JOHNSON, Chairman, Board of Public Works, Plattsmouth, Neb. May 18.

Precipitation Tanks, Etc.—At Winchester, Mass. Four precipitation tanks, engine house, auxiliary building, sludge well, branch sewer, 850 cu. yds. excavation, 75 cu. yds. brick masonry, 13 cu. yds. concrete. Plans and specifications at the office of the City Engineer, Boston. WM. B. SMART, Chairman, Water Board, Boston, Mass. May 19.

Sewer.—E. S. AUSTIN, Town Clerk, Cicero, Ill. May 21.

New Croton Aqueduct.—Deepening and finishing Shaft No. 24, on Section A; also constructing head house, etc. JAMES C. SPENCER, President, Aqueduct Commissioners, 280 Broadway, New York City. May 23.

Street Lighting.—Gas or electric light. D. STETSON, Chairman Gas Committee, Merchantville, N. J. June 5.

WATER.

Water-Works. — *Maine.* — Boothbay. Water-works are contemplated.——Waldoboro. Engineers are making surveys for a system of water-works to be built under a recent charter, and a water company will probably be organized. The town has voted to appropriate $600 a year for water-works. —— Portland. Work has been commenced on the Munjoy Hill reservoir, for which there will be about 80,000 cu. yds. of earth and 9,000 yds. of granite block paving. A large amount of pipe will be laid in connection with the two reservoirs during the present season.

Massachusetts.—Beverly. The Water Board has been authorized to complete the works within the appropriation.——New Bedford. The capacity of the distributing system of the water-works is to be increased one-third. The distributing reservoir has been emptied, and is being cleaned for the first time since 1869.

Rhode Island.—Burrillville. The vote on the proposition to contract with the Burrillville Water Co. for a

supply has been defeated by a vote of 80 to 67. Of 224 names on the voting list over 156 votes were cast.

New York.—Lockport.—The receiving tunnel for the new water-works has been enlarged and widened, and new gates are being put in at the entrance to the tunnel, which is at the head of the bulkhead of the race.——Ellicottville. Surveys have been made for a water supply by gravity.——Little Valley. It has been voted to bond the town for $15,000 for a water supply by gravity.——Phœnix. The Phœnix Water Co. has awarded the contract for pipe laying to W. A. WALTER.——Geneva. The town has made a contract with the Geneva Water Co. for a water supply. There will be 75 hydrants and 4 additional miles of 6 and 8-in. pipe, making 12 miles in all.——Albany. During the past year there were laid 4,909 ft. of 12-in. and 17,571 ft. of 6-in. mains; 338 ft. of hydrant pipes, and 21 hydrants set. ——Lansingburg. A vote on the issue of bonds for $25,000 for the storage reservoir will be taken May 22.

Pennsylvania.—Philadelphia. The Water Committee has under consideration ordinances granting permission to the Disston Water Co. to lay pipe in Tacony, and to the Holmesburg Water Co. to lay pipe in Holmesburg.

Maryland.—Hagerstown. The Washington County Water Co. is making extensive improvements at the well near the reservoir, for the purpose of obtaining an extra supply for the summer.——Baltimore. Larger mains are being laid by the water board,

Virginia.—Lexington. The water-works are to be enlarged and extended.

Kentucky.—Richmond. The Richmond Water-Works Co. has been organized: President, SAMUEL H. STONE; Secretary, F. H. ADAIR. Correspondence is solicited from contractors.

Tennessee.—Pulaski. Water-works are to be built. ——Monteagle. The engineers have arrived to make surveys for the new water-works. R. C. MORRIS, Chief Engineer. Work will be commenced soon.——Dyersburg. The town will put in water-works.

Georgia.—Columbus. The water company has let a contract for a stand-pipe 120 ft. high.

Alabama.—Calera. A water supply will soon be furnished from the city's reservoir.——Marion. Waterworks are projected.——Birmingham. The Elyton Land Co., at its annual meeting, held May 3, decided to begin work at once on an aqueduct to supply the city with water from the Cahaba river, 7 miles distant.

Mississippi.—Greenville. The City Council has granted an extension of time to the water-works company, the contract with which expired May 1. It was explained that the delay was due to incessant rains in the early spring, and to the tardiness of the city in furnishing street grades. The company has contracted to complete the works by Dec. 1, or forfeit $5,000.

Indiana.—Huntingburg. The Citizens' Gas & Water-Works Co will build water-works this summer. The water will be pumped to a reservoir at an elevation of 140 ft. There will be 5 miles of cast-iron pipe.

Illinois.—Galesburg. The city council has refused the offer of the bondholders to sell the the water-works plant to the city and settle the pending litigation for $62,500.——Hopedale. Work is said to have been stopped on the water-works. M. Houghton, of Delavan, is the contractor.

Minnesota.—Duluth. The St. Paul syndicate which owns the gas works and water-works has sold to N. W. Harris & Co., of Chicago, bankers, the balance of the 1st mortgage 20-year 6 per cent. bonds. Total issue, $700,000.——Austin. Water-works are being discussed.

Wisconsin.—Marinette. The council has accepted a proposition from the City Water Co. to lay wrought-iron pipe instead of cast-iron pipe in certain localities

Dakota.—Bismarck. The water-works have been shut down 10 days for repairs.

Iowa.—Creston. Water-works will be built this season by Comegys & Lewis, of New York. There will be a dam 20 ft. high and 700 ft. long, and the water will be pumped from the reservoir to a stand-pipe 125 ft. high and 25 ft. diameter. The mains will be 14 ins. diameter. There will be 80 hydrants, for which the city will pay $4,200 a year. The estimated cost of the works is $80,000.

Colorado.—Idaho Springs. Work upon the extension of the water-works is being actively prosecuted by the contractor, William Kitho. This extension now renders complete the system in all parts of the corporation. The upper part of town is growing so rapidly that the waterworks were necessary for protection from fire as well as for the convenience of a large number of tax payers.——Walsenburg. Water-works will be put in by Dr. T. F. MARTIN. The supply will be piped from lakes 3 miles distant at a considerable elevation. The works will cost $35,000.——Glenwood Springs. The mains for the waterworks are nearly all laid. The ditch for the pipe line above the power-house will be finished in 6 days. The flume for the water-works will be the longest undertaking in getting the water to the city. This will be finished early in June.——Colorado City. Russell & Alexander will lay 17,000 ft. of pipe for the Colorado City Water Co. ——Grand Junction. On May 1 the city voted to accept a proposition made by Mr. Krusen to put in water-works. The water will be drawn from the Gunnison river and pumped to a stand-pipe.

Oregon.—Baker City. Water-works are to be established.

California.—Red Bluff. The Antelope Creek & Red Bluff Water Co. has been incorporated by PETER DEEKEE and others. Capital stock, $300,000.——Grass Valley. Pipes for the new water-works are being laid by Geo. E. Turner.

Canada.—Hamilton, Ont. The Water-Works Committee will advertise for proposals for laying new water pipe, for which $10,000 have been appropriated.——Coburg, Ont. Water-works are projected.

Inspection of Illinois Water.—The State Board of Health, Springfield, Ill., has made arrangements for collecting samples of water weekly from various points on the principal streams in the State for a careful system of analysis. The experiments will continue for 6 months. The water will be collected in bottles at stated dates and sent to Chicago for analysis. The investigation will be devoted chiefly to streams from which water supplies are obtained.

Chicago Lake Tunnel.—The original plan for the tunnel now under construction provided for a submerged intake, which was approved by Mr. HERING, the Consulting Engineer, and the contract was let for this plan. Mayor ROCHE, however, reserved the right for the city to provide for a crib, and it is now probable that a crib will be built. The present and past City Engineers have sent the following communication to the Mayor: "In accordance with your request we have carefully considered the matter in reference to the proposed inlet to the lake tunnel and while we believe the original plan for the submerged inlet would be comparatively safe, we recommend that the openings to be made for taking in water be as near to the bottom of the lake as possible. The tunnel is to be extended so far from the shore, and for the reason that it will be impossible to secure and maintain a buoy during the winter season, and also impossible to locate the inlet by instrument during the night and in stormy weather, or to keep men for the purpose of doing work during a severe storm, the opening should be marked in a substantial manner and constructed in such a way that at any future time it may be accessible. For these and other substantial reasons that might be given, it is our opinion that it will be expedient to substitute a permanent structure for the temporary one contemplated in the contract, and that the additional expenditure that may be necessary will be for the best interests of the city.

W. R. NORTHWAY, *Acting City Engineer.*
SAMUEL G. ARTINGSTALL, C. E.

The finance committee has endorsed the statement and recommended the expenditure of the necessary amount for a permanent crib. At Washington the House has concurred in the Senate amendment to the bill authorizing the city of Chicago to build a crib in the lake and erect lights for its protection. Under the amendment the construction will be under the supervision of the Secretary of War.

Water Rights.—BERTHOUD, COL. April 28.—Our portion of the country is somewhat worked up over the recent ruling or order of the State Superintendent of Irrigation issuing an order to shut off the water supply, even for domestic use, until all the older ditches in each district have their full apportionment, not only for domestic use, but irrigating as well. This would, if fully carried out, ruin four-fifths of the farming portion of Colorado that depends upon irrigation. It is a well-known fact, both to the people and to the State authorities, that in nearly every case of some old ditch, usually only a few furrows along the river bottom and originally intended to irrigate a few acres of garden or a meadow, when the order was given to prove up priority on water rights, those same parties with a ditch carrying 200 or 300 ins. would prove up for 2,000 or 3,000 ins., or else sell their ditch to some corporation that would widen out the mouth of the ditch somewhat and file a claim for all the water in the stream, and lead it away from the settlers out on some new and high ground, and sell it to settlers in new localities, thus depriving the people along the stream, in instances, of even taking the water to drink, unless they had filed papers to the effect that they would require drinking water in future. In some cases, no doubt, the new order is necessary, but a general order of that kind would, if carried out, deprive one-half of the people of Northern Colorado, among the farmers, even of drinking water, in order that some old settler (who by false swearing proved up on the bulk of water in the stream he squatted upon) might flood his meadow.—Denver *Tribune Republican.*

The Columbus Real Estate & Improvement Co. has been incorporated at Columbus, Neb., by J. P. BECKER, JONAS WELSH, D. SCHUPBACK, A. JAEGGI, H. OEHLRICH, and C. H. DAVIS. Capital stock, $100,000. The company will construct a canal from the Loup river to the city with flumes, reservoirs and conduits, and will erect manufacturing plants to be operated by water power.

Irrigation Water Rates.—The County Commissioners have fixed the price of water in Bent Co., Colorado, at $1.50 an inch, with which the farmers generally will be satisfied.——The County Commissioners have fixed the rate at $2.50 per inch for all persons using water from the city ditch at Denver, Col., between the city limits and the herd gate.

Water Waste.—The Water Board of St. Paul, Minn., finds that the waste of water is very great. It has been found that the people on St. Anthony's Hill and Dayton's Bluff are taking 35,000 galls. per hour between 11 P. M. and 4 A. M., the greater portion of which must be waste, as people have no use for such an amount of water at those hours of the night. If they used that amount through the 24 hours it would amount to 840,000 galls. All the revenue derived from water service is used for the extension of the water system of the city, which is progressing at a rate of 20 to 30 miles of mains per year.

Sanitary Conference.—Secretary RAUCH of the Illinois State Board of Health has issued a circular letter to municipal and village officers to attend a sanitary conference at the State Capital, Springfield, May 17 and 18, at which the following questions will be considered: The removal and disposal of garbage; Water supply and the pollution of streams; The methods of prevention, and of the suppression of epidemics of contagious and infectious diseases; The disposal of night-soil and excretion; Registration of vital statistics.

Minneapolis, Minn.—The following is from the report of Supervisor WALSH, on the operations of the water department last year: Total miles of mains in use, 111: laid in 1887, 22 miles; to be laid 1888, 19 miles, 12,000 ft. of which is 36-in. pipe leading from the pumping station in North Minneapolis: number of fire hydrants, 1,412, of which 380 were placed last year, together with 171 used for street sprinkling purposes. The total amount of water pumped last year was as follows: West side station, 2,669,546,794 galls.: East side, 1,234,420,736 galls.: auxiliary station at Eighteenth Ave. north, 23,958,833 galls. The total pumping capacity after the completion of the Shingle Creek station will be 30,000,000 galls. daily.

The Volker & Felthousen Mfg. Co., of Buffalo, N. Y., will take possession of its new building on May 15th. It is an erecting room immediately adjoining the works, 50 x 70 ft. and 29 ft. high. The company is building the plant for eight water-works, and keeps the works running every evening.

Boothbay, Me.— HUDSON, MASS. May 3, 1888.

EDITOR ENGINEERING NEWS:—Water-works are to be built at Boothbay, Me., by the Boothbay Water Co., of which H. A. HANCOX is President and CHAS. H. FISHER, Secretary and Treasurer. The company has capital stock and bonds amounting to $50,000, and a franchise for 25 years giving an annual hydrant rental of $1 450 for 22 hydrants and $50 each for all additional ones. The designing and constructing engineer is H. A. HANCOX, Hudson, Mass. We have purchased all our material and expect to let contracts for labor next week and break ground about May 15. We have bought a duplex, compound condensing pump with a daily capacity of 1,000,000 galls., from the Volker & Felthousen Mfg. Co., Buffalo, N. Y. Our pipe, specials, valves and hydrants are furnished by R. D. Wood & Co., Philadelphia, Pa. Our stand-pipe is 30 by 48 ft., has a capacity of 250,000 galls., and is to be made by E. Hodge & Co., South Boston, Mass. There will be 4.6 miles of pipe and the completed works are estimated to cost $60,000.

H. A. HANCOX, *Prest. Boothbay Water Co.*

Brooklyn, N. Y.—Last week the Aldermanic Committee on Water and Drainage for the first time considered the matter of extending the water supply, which has been pending since Nov., 1885, and over which there has been so much discussion and delay. The matter has been delayed so long that even if work should be commenced at once there would probably be a water famine before the new supply could be available. Commissioner ADAMS presented at the meeting plans providing for early and temporary relief: one plan for a new engine-house and 2 new pumping engines at Ridgewood, which would cost $287,000, and take a year to build; the other plan for sinking driven wells in the low marshy ground at Baisley's pond, from which a large supply could be pumped. The conditions of this pond are such that a large quantity of water runs to waste. The level of the branch conduit connecting the pond with the main conduit is so low that when the latter is running at more than 50 000,000 galls. a day the water backs up through the branch conduit into the pond, overflows at the weir and is lost. To remedy this defect at the pond it would be necessary to raise the weir 2 ft., so that a considerable area of land lying between the pond and Jamaica would be flooded. In order to avoid this it is proposed to get the water from outside the pond by driven wells. It is the small connecting conduit through which the water backs, owing to the difference of level. The main conduit is entirely adequate. The engineers showed that distinctly. Its nominal capacity is 50,000,000 galls., and the daily average delivery last year was some 42,000,000 galls. But it has been run up to 65,000,000 in 24 hours, and it can carry 75,000,000 or 80,000,000. The meeting was adjourned to allow the members to examine the plans. The aldermen made their annual inspection of the water-works

on Thursday, but as the reservoirs and streams are full at this season, there are no indications of the trouble which is experienced every summer.

Commenting on this subject the Brooklyn *Eagle* says: "Commissioner ADAMS urged upon the Water and Drainage Committee his plans for early relief. There is no objection to their consideration, there may even be a necessity for it, provided the main business is not neglected. No doubt it will be regarded by citizens educated in a suspicion of alderman as significant and unsatisfactory that so much was said about the temporary expedients and so little about the permanent enlargement. If the concession of the former is to be made a pretext for rejecting the latter the public will be likely to demand that the extension shall be first forwarded, and will even take the chances on self denial and parsimony in the use of water in order to make sure of the future."

Steam Pumping Engine Governor.—In our account of the list of Exhibits at the Cleveland Water-Works Convention we omitted to mention the Fisher Governor Co. of Marshalltown, Ia., represented by its very genial Secretary, E. A. HARRIS. The exhibit of the company was a Reducing Valve—a device for use in any pump working direct, or against pressure, to maintain uniform pressure at any point desired. The device has been very successful and has given great satisfaction both in steam pumping engines and hydraulic elevators. Mr. HARRIS exhibited a working machine taken from the stock.

Red Lake River Improvement.—The Chief of Engineers has received the following report on the improvement of Red Lake river, Minnesota: From Red lake to Thief river the stream is sluggish, with a general width of 200 ft. and depth of 2 ft. at low water. With the exception of occasional bowlders in the bed of the stream no obstructions to a 2-ft. navigation exist in this section. From Thief river to Fisher's Landing the bed of the stream is incumbered by immense quantities of bowlders and occasional small rapids. From Fisher's Landing to the junction of the river with the Red river the current is sluggish, the width of the stream averaging 150 ft., and depth at low water 2½ ft. Since the extension of the railroads the steamboats have been withdrawn from Red Lake river, which is now spanned near its mouth by an iron highway bridge, thus practically closing the river to Red River boats. The construction of a reservoir dam at Red Lake, and the equalization of the discharge would be of material benefit to such portions of Red Lake river as are navigable without the construction of locks and dams, and would be of incalculable benefit to the Red River of the North in connection with the present project of improvement, by increasing the volume of water during the low water period, and in reducing the Spring floods, which are very often disastrous in the Red River valley. With reference to the possible improvement of Red Lake river it would appear that the portion from Red lake to Thief river is fairly navigable without much if any improvement. From Thief river to Fisher's Landing the river can only be made navigable by the construction of a series of locks and dams, an expensive improvement that the requirements of commerce can hardly be claimed to demand as yet, at any rate. From Fisher's Landing to the outlet but little improvement would be necessary, other than the removal of snags, overhanging trees, and possibly a little dredging.

Annual Reports.

Newburg, N. Y.—The Water Commissioners have issued their report for the year ending March 12, 1888, being the 22nd annual report. Immediate steps are recommended for the prevention of the extravagant waste of water, and to secure a larger supply of water. During the year 9,584 ft. of pipe were laid; also 16 hydrants and 25 Eddy valve gates set; there are now 227 hydrants and 230 gates. WM. C. MILLER is Superintendent.

Bridgeton, N. J.—Superintendent TIMOTHY WOODRUFF has issued his report for 1887. The pumping plant is in good condition, but as it is has been in use for 10 years it is recommended that it be duplicated, in case of accident to the original plant. A well, 28 ft. deep and 30 ft. diameter, was built by J. H. Hanes, of Cape May the cost, including 275 ft. of 16-in. suction, was $4,700. The maximum flow of water into the well at a distance of 4 or 5 ft. from the bottom, is 400 galls. per minute. The total consumption was 90,162,000. There are 15.75 miles of 1¼ to 16-in. pipe, 103 hydrants and 144 stop gates. During the year 3,648 ft. of 4, 6 and 16-in. pipe were laid; 5 hydrants and 7 stop valves added; also 97 new attachments on which were 158 new water takers. An electric alarm gauge has been put in to keep the engineer at the pumping station informed of the depth of water in the reservoir.

Waltham, Mass.—The Water Commissioners have issued their report for the year ending Jan. 2, 1888, being the 15th annual report. Experiments are being made for an increased water supply, and a test well has been sunk to a depth of 83 ft.; a material increase is promised. This work is under the charge of M. M. TIDD, C. E., whose plan provides for 16 4-in. wells, on the gang-well system. During the year 8,747 ft. of 2 to 6-in. mains have been laid, 10 hydrants and 155 services added. The reservoir and filter basin are in good condition. There are now 34 miles 1,739 ft. of cement, cast-iron and wrought-iron mains, 188 hydrants and 23 meters. The total amount of water pumped was 198,609,670 galls. The work were built 1872-3 and are owned by the city. The supply is by pumping from a filter basin near Charles river; Worthington pumps being used. GEO. E. WINSLOW is Superintendent.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated.)

(CONTINUED FROM PAGE 372).

Morrisburg, Ont.—The works were commenced in April, 1887, and completed in December, 1887. The engineer was WM. KENNEDY, of Owen Sound, Ont. The contractors were: for pumping machinery and pump house, A. Jeffrey, of Montreal; for pipe and specials, Bellhouse, Dillon & Co., of Montreal, agents for an English firm; for valves, hydrants, trenching and pipe laying, M. Ryan, of Toronto. The supply is by direct pumping from the St. Lawrence river by water power, the power being obtained from the canal. A 14-in. duplex Blake steam pump will be put in for emergencies or in case of the canal being emptied, as it generally is for a few days for repairs, before the opening of navigation; also a horizontal tubular boiler 54 ins. diameter, 12. ft. tubes. The pumping plant consists of a Silsby rotary pump, for fire protection, duty 1,000 galls. per minute, working against 90 lbs. pressure in the air vesse , driven by a 61-in. diameter Leffel waterwheel; power from the St. Lawrence canal, head 8 to 10 ft. Also a single acting plunger pump for domestic service: 3 cylinders 7⅛ ins. diameter and 20-in. stroke; duty 350 galls. per minute against 90 lbs. pressure in the air vessel, driven by a 40-in. water-wheel. Normal pressure about 40 lbs. Both pumps have been tested to 160 lbs. pressure, and are expected to work up to 120 lbs. in case of fire. The machinery is arranged for either water-wheel to drive either pump, or both wheels to drive either pump, or to be coupled and run both pumps.

There are 3 miles of 5, 6 and 8-in. mains, and 22 hydrants. Ordinary pressure, 40 lbs.; fire pressure, 120 lbs. The works cost $26,000, including the steam pump; debt, $25,000; rate of interest, 5 per cent. Annual expense about $400; annual revenue not ascertained as the mains were not ready in time to make many connections before winter closed in. There will be no charge to village for hydrants. The works are owned by the village, and controlled by the village council. The working is stated to be all that can be desired, and the capacity and force are greatly in excess of present needs. Present population, 2,000.

Hobart, N. Y.—The works were commenced June 17, 1887, and accepted Sept. 12, 1887. The engineer was GEO. N. COWAN, of Stamford, N. Y. The contractor for the buildings, reservoir, trenching and pipe laying, was Francis Leonard, of Norwalk, Conn.: the pipe was furnished by the Norwalk Water Pipe & Construction Co., Norwalk, Conn.; Ludlow valves and Holyoke hydrants are used. The supply is by gravity from Spring brook, and there is a reservoir with a capacity of 380,000 galls. There are 2 miles of mains, 10 hydrants, and 16 taps; the mains are of cement pipe and the service pipes of lead. Average daily consumption, 1,000 galls. Fire pressure, 60 lbs. The works cost $10,225, debt $2,000; rate of interest, 6 per cent. The annual expense is not yet determined; annual revenue per consumer about $300. The franchise is for 99 years; the hydrant rental is not yet determined. The works are owned by the Hobart Water Co.; President, JAS. COWAN; Secretary, JAMES R. SCOTT, Hobart, N. Y.; capital stock, $12,000. Present population, 1,000.

Greenbush, N. Y.—The works were commenced June 20, 1887, and completed and accepted Nov. 10, 1887. The engineer was F. S. PECKE, of Watertown, N. Y. The contract for the entire work was taken by Moffett, Hodgkins & Clarke, of Watertown, N.Y.; the other contractors were; for masonry, foundations and buildings, Henry Brown, Bath-on-Hudson, N. Y.; for pumping machinery, H. R. Worthington, of New York City; for pipe and specials, Warren Foundry & Machine Co., of New York City; for valves and hydrants, Ludlow Valve Mfg. Co., of Troy, N. Y.; for stand-pipe, Riter & Conley, of Pittsburg, Pa. The supply is obtained from a well 20 × 30 ft. and a pipe to the Hudson river; the water is pumped to a stand-pipe 25 × 80 ft. The pumping machinery consists of 2 Worthington engines, 12 and 20 × 12 × 15, a No. 5 condenser, and two 80 H. P. return tubular steel boilers; the aggregate daily capacity is 4,000,000 galls. There are 13 miles of pipe, and 131 hydrants; the mains are of cast-iron and the service pipes of galvanized iron. Ordinary pressure 80 to 100 lbs.; fire pressure 140 lbs. and upwards. The works are owned by the Greenbush Water-Works Co.; President, J. F. MOFFETT; Secretary, F. S. PECKE; Superintendent, O. W. WEED, of Sandy Creek, N. Y.; capital stock, $250,000. Present population, 9,000.

(TO BE CONTINUED).

Special Reports of Water-Works Construction.

THE ENGINEERING NEWS MANUAL OF AMERICAN WATER-WORKS is now being compiled, and will be *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and will be of great value to Water-Works superintendents and projectors of new works.

Superintendents of water-works and water companies will wish to see correct and complete data concerning their Works in our MANUAL, and to ensure this they should send in reports *at once* upon the blanks which we have already sent to every Water-Works office in the United States and Canada. Many have delayed their report, and if the blanks we intended for them have been lost in the mail, or mislaid, we will send more upon request.

We *must* have a report from every public water supply system in North America, so those who reply to our inquiries at once will save a second inquiry. We also wish to know of *every* new Water-Works plant in process of construction, and of *every* new project in this line. We will send to any one desiring them, blanks upon which reports can be made.

Further details of the MANUAL will be advertised later. We abstract from our special reports for the MANUAL the following items of current interest.

CINCINNATI, O., May 4, 1888.

EDITOR ENGINEERING NEWS:—Our company has contracted with city of Memphis, Ky., for the exclusive right for 25 years of taking water from their works for the purpose of supplying Dayton and Bellevue. We furnish Bellevue with 40 hydrants at $25 each. This only covers one half of the town and we soon expect to locate 40 more hydrants at the same rate. At an early date we also expect to close a contract with Dayton to furnish that place with water. They have just obtained the necessary legislation for this purpose.

As our mains are connected directly with those of the Newport works we have no operating expenses save to pay Newport for our water the rate of 7 cents per 1000 galls. The name of our company is the Bellevue Water & Gas Co., WM. W. POST is President and G. R. HARMS, Secretary, Treasurer and Superintendent. The hydrant rental is $25 a year. The works at Bellevue will cost $35,000. G. R. HARMS.

LAKE CITY, Fla., May 4, 1888.

EDITOR ENGINEERING NEWS:—The Lake City Water & Light Company has nearly completed a system of water-works at this place at a cost of $15,000. Water is pumped from Lake Isabella to a tank 60 ft. in height having a capacity of 16,000 galls. The city rents 30 hydrants at $20. Our pumping machinery consists of two Worthington pumps, one being used only in case of an emergency. NOYES S. COLLINS, is President of the company and has charge of construction. A. B. HART.

HOLDREGE, Neb., May 4, 1888.

EDITOR ENGINEERING NEWS:—I see by your paper that you wish reports of water-works under construction. I was awarded the franchise for works here Jan. 31, and began work April 16. The pipe is now all on the ground, 400 tons, and the trenches are being dug. We expect to complete the system by July 1, at a cost of $80,000. The mode of supply is by pumping to reservoir and stand pipe. We already have many applications for water, as wells are few and water is found only by going down 170 ft.; at present water is delivered by wagons at 10 cts. a barrel. The city pays $65 each for 52 hydrants and it is probable that at least 25 more hydrants will be wanted soon, as the city is growing rapidly. BEN. S. CLARKE.

KANSAS CITY, Mo., May 4, 1888.

EDITOR ENGINEERING NEWS:—Referring to your request for information concerning "every new project" in water-works, I give the following notes from my report of last month to the Rogers, (Ark.) Lime & Water Co.:

Population about 1,500. Present supply from spring about 145 ft. below the town. This is owned by the St. Louis & San Francisco R. R. Co., liable to future pollution, and affording but 303,450 galls. per day in winter and wet months, and less in summer. "Diamond spring" affords 876,300 galls. per day continually, of excellent quality, and is believed to be the only other available source. It lies 170 ft. below the town. It is proposed to take the latter by a flume 17 x 17 ins. inside, or by a pipe 2,800 ft. down the stream, where an effective head of 29 ft. may be had on a turbine. From this point it is proposed to pump against a total head of 296 ft. by 4-in. pipe to stand-pipe, or tank some 50,000 galls. per day. This can be supplemented, during emergencies, by a small steam pump placed on a stream now used by the railroad.

The above works would be rather insignificant but for the limitations imposed, which give it some interest. KENNETH LEN.

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